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A comparative social benefit-cost analysis of the twelve principal projects of Peru's public investment program 1968-1975

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I. INTRODUCTION

Investment plans, whether at the national, regional, or sectoral level are the core of development plans. In order to reach national objectives the investment projects must be properly selected. In terms of national planning the stated objectives generally refer to the growth in national income, balance of payments equilibrium, a reduction in unemployment or underemployment, price stability, etc. The selection of investment projects must be consistent and appropriate with these general objectives of national economic policy.

In terms of regional planning, the stated objectives generally refer to the growth and balanced development of the different regions that constitute the nation. For this, one generally looks for the possibility of utilizing to the fullest extent possible the available resources of each region. A properly worked out investment plan must allow for the necessary compatibility between national development plans and regional development plans.

The national investment program is also directly related to sector planning, be it with respect to the selection of those sectors which are considered to be of higher priority than others or with respect to specific activities that are to be given priorities within those sectors or with respect to the desired and/or required rates of growth as implicitly derived from the general objectives stated in the national development plan. Because of this an investment program is necessarily a major component of a national development plan. A separation between the selection of projects and planning at the national level necessarily brings about a series of effects that must obstruct the fulfillment of the objectives of the development plan.

In this thesis we will initially revise the major criteria that are in use to evaluate investment expenditures. In the analysis of these criteria we will show systematically how such criteria when used as an instrument of analysis allow us to translate the incidence of an investment project in terms of the stated objectives in the development plan. Given this we will be in a position to establish whether the selected projects are consistent and compatible with the already defined objectives. In other words, with the application of project evaluation criteria from the social point of view we will search for a comparison, selection, ordering and quantification of the social economic effects of the projects in portfolio and/or projects in execution and their consistency with stated national objectives.

In Chapter II we present a review of project evaluation criteria. First, we consider the traditional or commercial criteria which are very frequently used as decision criteria for capital expenditures. Above criteria are not particularly useful in the evaluation of the large-scale public investment projects subsequently analyzed in this thesis. But their inclusion is nevertheless useful because frequently minor sub-components of the investment program, as related to specific investment projects, could usefully utilize these types of criteria.

Initially we analyze the so-called crude investment criteria. In what follows we make reference to five of these which in our opinion are the most representative of such criteria. Among these, we have the pay-back method. This method gives us the time necessary during which the initial investment will be totally recovered. Next we refer to the method of the average arithmetic rate of return, which compares the average annual net income with the initial investment. On the other hand the annual cost method looks for that project among available projects which results in the minimum annual cost. The annual return on capital employed method relates the net profit generated to the capital employed during the lifetime of the several projects. The fifth crude evaluation criterion is commonly known as the MAPI method as formulated by the Machinery and Allied Products Institute. This method not only determines the average return of the investment but also permits the selection of the optimal moment of time at which to renovate fixed capital.

The common characteristic of these five crude investment criteria is that none of them considers the value aspect of money over time; that is, none of these methods uses a discounting approach. We illustrate these characteristics, advantages, disadvantages, etc. with particular examples. In the next section we analyze the method of net present value and the internal rate of return. In the discussion of these criteria we also make reference to possible variations and conventions utilized in their practical application.

The above traditional methods have repeatedly proven their value as a criterion for the selection of investment projects in the private sector. But their usefulness within the context of a large-scale investment program is limited. The arguments against traditional commercial criteria are discussed in greater detail subsequently.

In Chapter III we present the conceptual basis of social benefit-cost analysis. Initially we start out with the basic postulates of the perfectly competitive model and its implication in the evaluation of projects both for a well-developed economy and for a lesser-developed economy. Given the existence of certain market imperfections in the economics of lesser-developed countries the prices generated in the several commodity and factor markets do not truly reflect the social opportunity cost of the factors of production.

The causes of these imperfections are quite diverse. Among those occurring most frequently are those of a fixed or institutionally determined wage rate, controlled exchange rates, an attempt to fix the prices of specific commodities as a matter of social policy, the existence of monopolistic and monopsonistic market structures, etc. Given these conditions it is often necessary when evaluating an investment project to adjust the prices of the principal inputs and outputs so that they may reflect their real social opportunity cost. In this context we analyze the currently most advanced methodologies with respect to the proper selection of the social rate of discount to be subsequently used in project evaluation. Specifically we analyze the selection of the social rate of discount taking into account the criterion of social opportunity cost and taking into account the social time preference rate approach.

Given this we present the theoretical basis for the determination of the shadow price of labor. We discuss in detail the different formulations as associated with different methodologies. Subsequently we present the theoretical basis of the determination of the shadow price of foreign exchange, again indicating the several existing methodological variations in this respect.

In Chapter IV we develop in detail the conceptual basis of social evaluation criteria which we subsequently apply to a number of important projects appearing in the Peruvian national investment program. We first of all analyze and discuss the method proposed by Steven Marglin. Given Marglin's approach we calculate the net present value, the benefit-cost ratio and the internal rate of return. The indexes of social profitability are expressed with the consumers goods as the numeraire.

This method allows us to identify the contribution and the distribution of costs and associated benefits with respect to the distinct economic groups or classes associated or affected by the project. This allows us to identify and to assign the distributional shares of costs and benefits as related to the public sector, the private sector, wage earners, farmers or whatever other economic group associated or affected by the project.

The practical application of these methods proceeds in three successive steps. During the first step we evaluate the projects using actual market prices. In the second step we then switch to the utilization of shadow prices. In the final and third step we calculate the distributional shares of benefits and costs with respect to the different economically identifiable groups that participate in or are affected by the project. After this we proceed to determine the indexes of profitability according to the consumption generated for each participating group.

Subsequently we present the method proposed by Little and Mirrlees. As before we determine the net present value, the benefit-cost ratio and the internal rate of return. However with this method we utilize investment as a numeraire.

After this we analyze the method of marginal social productivity of capital as proposed by Hollis Chenery. This method allows us to measure the contribution of a project to national income and to the balance of payments. In the practical application of this method, we also consider three variants. Initially we consider the cost of the projects as a given total amount and the annual flows as given annual averages without having recourse to a discounting process. In a second step we express the respective cost flows and benefit flows in annual equivalent values. In a third step we then also consider the utilization of shadow prices for strategic inputs.

Finally we present the method originated by Tinbergen and commonly known as semi input-output. With this method we determine a benefit-cost ratio taking into account the intersectoral effects originated by the initial investment.

In Chapter V we give a brief description and analyze the evolution of the Peruvian economy during the period 1968-1975.

In Chapter VI we analyze the economic evaluation of the selected projects for this study according to the above mentioned criteria. Initially we give a brief description of these twelve investment projects. These projects belong respectively to the agricultural, industrial and mining sectors. The projects chosen represent the most important projects of their kind within their respective sectors. They furthermore reflect the strategy of the Peruvian government in the investment field.

Subsequently we describe the adjustments which were necessary with respect to the statistical information as contained in the feasibility studies. These adjustments were necessary in order to come up with a uniform structure of concepts so as to be able to compare different projects. Also there is a tendency to overevaluate the benefits and to underestimate the costs associated with the projects. For this purpose it was necessary to visit the projects and those in charge so as to verify at the field level the prices and expected quantities to be produced. Finally we have chosen to express the costs and the benefits of these projects with respect to the same base year.

After having made the statistical adjustments we proceeded to specify the assumptions and definitions of the variables and parameters associated with each evaluation criterion. Subsequently we determined for each of the twelve projects their respective indexes of social profitability. At the same time we proceeded to make comparisons between projects and obtained respective rankings of these projects according to the results obtained for each evaluation criterion.

For the definitive version of Marglin's method we have also made a sensitivity analysis taking into account the interdependencies between the shadow price of capital, the shadow price of labor and the social rate of discount.

In Chapter VII we then present the major conclusions of this study. An appendix contains the data which underlie the evaluation of the projects here discussed.

II. TRADITIONAL CRITERIA FOR PROJECTS EVALUATION

A. Crude Investment Criteria

1. The payback method

The payback period is one of the simplest and best known methods in project evaluation. It can be defined as the time period during which the initial investment is totally recovered [6, 8]. It is not, in the immediate sense of the word a measure of profitability. The calculation of the payback period can be done in two alternative ways. If the annual net revenues are equal between years then the payback period is given by the quotient between the initial investment and the annual net revenue. Alternatively one can subtract the successive annual revenues from the initial investment until the result equals to zero. The number of subtractions performed determine the payback period.

A variant of this method is known as that of the cut-off period criterion. This consists in the predetermination of a maximum recovery period. Those projects that exceed the cut-off period are eliminated and generally the alternative with the minimum payback period is selected.

The users of the payback method justify its application whenever the recovery period is a critical project decision parameter, as for example when uncertainty due to the range of possible annual revenues increases as time goes by.

This is the case in those industries subject to rapid technological change, such that industries must replace plant and equipment. It is also relevant when product or production methods cannot be protected through patents. Sometimes uncertainty due to the continuation of a fixed period operations contract also advocates the use of the payback method.

2. The average rate of return method

The objective of this method is to determine the average return of capital invested. This method compares the sum of expected annual benefits with the initial investment [1, 56].

Generally annual benefits are taken to be annual net revenues allowing for operation, maintenance and taxes. Sometimes only the revenues of the first years are included. This is because estimates of revenues beyond the first four or five years become too unreliable. In another alternative one restricts benefits to the most frequent expected annual revenues, i.e. the mode. This is because large inter-annual fluctuations in net revenue might distort a simple average. The average rate of return method should be used only as a complementary method in a project evaluation. Its use provides acceptable results when evaluating small or rapidly depreciating investments.

3. The annual cost method

The annual cost method [42] selects that investment alternative which requires the least annual outlay. It is therefore a cost minimization criterion. Its principal feature is to treat revenue as a cost. The annual revenue is determined as a percentage of the initial investment as determined by the investor.

Suppose that a firm wants to increase its operations in accounting. For that purpose it can choose between two alternatives, a highly mechanized system (Plan A) or semi-automatic system (Plan B). The basic information and calculations for both alternatives are given in Table 2.1.

Table 2.1. Summary form of the annual cost method

Item	Plan A (dollars)	Plan B (dollars)
1. Initial investment	800,000	80,000
2. Total annual cost	244,800	183,280
Return on investment	112,000	11,200
Operation cost	40,000	160,000
Depreciation	48,000	7,600
Taxes	44,800	4,480
3. Useful life	15 years	10 years

Fixed investment is linearly depreciated. The average tax rate is 40 percent of annual revenues. The investor desires a minimum return of 14 percent in view of the market for this type of services. The firm can borrow outside capital at 7 percent.

In Table 2.1, Plan A generates a return of $112,000 per year, whereas Plan B generates $11,200 annually. The difference in recurrent costs is explained by the difference in labor intensity of the two systems.

Given these conditions, the annual cost method would select Plan B as the most attractive because its annual cost of $183,280 is less than that of alternative A, which equals $244,800.

There are several questionable steps in the application and justification of this method. Foremost is the peculiar treatment of revenue as a cost, because if investment increases the annual cost will increase proportionally. Revenues are not tied in any form with prices and quantities produced. Similarly the selection of the desired rate of return is entirely too subjective. Generally the method will be biased in favor of labor intensive systems.

4. The annual return on capital employed method

Generally the success of a business enterprise can be measured with respect to profits earned. But such profits earned must be expressed relative to certain other financial indicators. For example one can express profits in relation to the total capital employed or profits earned relative to sales. The annual return on capital employed method [52] results when we express net profits earned in relation to the net tangible capital used during a specific period. For purposes of investment evaluation we would select that alternative which increases this ratio in greatest proportion.

Frequently we can also use its application in the context of additional projects in the sense that we measure the additional profits generated with respect to the additional capital employed.

Let us suppose that at a given moment of time the total capital of a firm amounts to $800,000 which has been financed by 10,000 outstanding common shares each with a nominal value of $80.00 per share. The net profits generated during the last year of operations were $80,000, or a return of 10 percent over the capital employed.

The firm wants to decide whether it should engage in an additional investment equal to $50,000 which would be covered by an additional emission of 625 shares each at a nominal value of 80 dollars.

The amount of capital so raised can be utilized for two projects. The alternative A has a potential earnings of $9,000 per year for the next 15 years, whereas alternative B generates $12,000 per year but only for the next 9 years.

Table 2.2. Summary form of the annual return on capital employed method

Item	Alternative A (dollars)	Alternative B (dollars)
1. Annual net profits	89,000	92,000
Before new investment	80,000	80,000
After new investment	9,000	12,000
2. Capital employed	850,000	850,000
Before new investment	800,000	800,000
After new investment	50,000	50,000
3. Return on capital as a percentage of net profits over capital employed		
Before new investment	10.0%	10.0%
After new investment	10.5%	10.8%

With respect to Table 2.2 we see that the selected alternative will be Alternative B because its return to capital employed of 10.8% is larger than that in Alternative A which equals 10.5%. That is to say, alternative B increases in a greater proportion the profits of the firm relative to alternative A. Note that the return on capital before the new investment was 10 percent.

As we can appreciate, the above method takes as an evaluation criterion a specific rate of return but as a method of project evaluation and particularly as a method of comparison between projects, it is very simple.

In the example used we can see that alternative A has been eliminated even though it generates the greatest amount of profits. This is because the profits generated in this project continue for an additional six years.

Also, this method does not allow us to compare other characteristics of the projects, for example, operation costs, maintenance costs, the amount of production, etc.

In conclusion we must emphasize that this method is based on accounting concepts which can be easily modified. Consequently a different definition of capital or components of capital can seriously affect the results obtained. Specifically a decrease in working capital will increase the total amount of capital available given the accounting definition that tangible net worth is arrived at as the difference between assets and liabilities.

5. The MAPI method

The MAPI method [67] is closely tied to the problem of renewal of fixed assets (machinery, equipment, etc.). That is to say, it helps to determine the most opportune moment for a company to replace their existing installations.

The MAPI method is a profitability index, indicating the return on average net investment. The rate of return is determined by the quotient of the average benefits over the average net investment for the whole of the period under consideration.

The application of this method is based on a standard format containing the basic information, as in Table 2.3. The project in question and the existing alternative is initially specified in the format. One alternative may be to keep the presently existing assets. The period of analysis is usually a year, but it can be extended to longer periods. The first part of the format allows us to determine the "operating advantage" or net result. In Part IA the effect on revenue is measured by changes in product quality and/or volume of production. The effect on costs is measured in Part IB. The combined effect or the annual operating advantage is the difference between the effect on revenue and costs and is determined in Part IC.

In Part II one determines the average net investment and the rate of return thereon. Tax incentives may lessen the net cost of the project. If we deduct from the net cost the anticipated investment for the period and the salvage value of the reserved assets of the project we obtain the initial net investment, as in Part IIA.

In Part IIB one determines the retention value at the end of the period of analysis. It can be understood as the initial investment less a capital consumption allowance.

In Part IIC one calculates the return on investment as the quotient between the annual operative advantage after taxes, with respect to average net investment.

Suppose that the Alfa Corporation wants to renew their fixed assets. The cost of the new asset is \$14,000, including installation and freight. The estimated service life is 16 years, after which it will retain an expected salvage value of 10 percent of acquisition cost. The replaced assets do not have a salvage value.

Referring to Table 2.3 we observe that the annual operating advantage equals \$6,500 which is the net effect of the increase in revenues and the reduction in operating costs of \$1,000 and \$5,500 respectively.

The initial net investment of \$14,000 equals net cost. This because we assume a zero salvage value for the existing equipment and no other capital additions are foreseen for this period. We further assume the absence of any tax incentives.

Part IIB contains the asset's retention value at the end of the period. In this case a service life of 16 years and a salvage value of 10 percent, results in a survival percentage of 93 percent after the first year. The retention value is given by the net cost multiplied by this percentage, or 13,020 dollars. In this case the terminal net investment equals the retention value of the asset at the end of the period of analysis. The average net investment given an initial net investment of 14,000 dollars and a terminal net investment of 13,020 dollars, equals 13,510 dollars.

Given linear depreciation and a salvage rate of 10 percent, annual depreciation equals \$787.50. Taxes are levied on the annual operating advantage minus depreciation. With a marginal rate of 60 percent, taxes equal 3,427.50 dollars.

Table 2.3. MAPI method summary form

Project: Purchase of new equipment

Alternative: Continuing as it is

Comparison period (n): one year

Part I. Operating advantage

		Increase (dollars)	Decrease (dollars)
A.	Effect of project on revenue		
1.	From change in quality of products	--	--
2.	From change in volume of output	1,000	--
3.	Total	1,000	--
B.	Effect on operating cost		
4.	Direct labor	--	3,600
5.	Indirect labor	--	1,100
6.	Inputs	--	300
7.	Materials	--	100
8.	Maintenance	--	150
9.	Power	--	--
10.	Subcontracting	--	50
11.	Inventory	--	--
12.	Insurance	--	200
13.	Others	--	--
14.	Total	--	5,500

Table 2.3. Continued

	Increase	Decrease
	(dollars)	
C. Net effect		
15. Net increase in revenue	1,000	--
16. Net decrease in operating costs	--	5,500
17. Annual operating advantage	6,500	
Part II. Investment and return		(dollars)
A. Initial investment		
18. Installed cost of project minus initial tax benefit		14,000
Net cost		14,000
19. Investment in alternative		--
Capital additions minus initial tax benefits		--
Disposal value of assets retired by project		--
20. Initial net investment (18-19)		14,000
B. Terminal investment		
21. Retention value of project		13,020
22. Disposal value of alternative		--
23. Terminal investment (21-22)		13,020
C. Return		
24. Average net capital consumption (20-23)/N		980
25. Average net investment (20+23)/2		13,510
26. Before tax return (17-24)/(25) x 100		40.86%
27. Increase in depreciation and interest deductions		787.50
28. Taxable operating advantage (17-27)		5,712.5

Table 2.3 Continued

29.	Increase in income tax (28 x tax rate)	3,427.5
30.	After tax operating advantage (17-29)	3,072.5
31.	Available for return on investment (30-24)	2,092.5
32.	After tax return (31/25) x 100	15.49%

The net returns equal the annual operating advantage minus taxes and the capital consumption allowance, or 2,092.50 dollars.

Finally the rate of return equals the ratio between above calculated figure and average net investment, or 15.5 percent.

We could follow the same procedure for alternative assets, and then choose the alternative with the largest annual rate of return.

The MAPI method, represents an orderly and systematic approach to investment analysis. Its basic merit is the incorporation of the concepts of service life, obsolescence and depreciation in the calculation of the rate of return. On the other hand the method is not practical, for the evaluation and comparison of large scale complex projects. Finally, the use of averages will bias the results when the annual flows are subject to substantial variations.

B. Discounted Cash Flow Methods

One common disadvantage of the use of crude investment criteria is the calculation of benefits in terms of accounting concepts. This is not necessarily compatible with a correct analysis of capital expenditures for several reasons. Financial accounting is fundamentally set up to report past events about the behavior of a specific variable or accounting concept. The analysis is linked to a predetermined accounting period, generally one year. Similarly the choice of accounting method implies that benefits can be manipulated according to the method selected. For a given objective this will give different results. On the other hand the natural accounting period for any project is given by the cash flows that occur during the project's useful life.

Given differences in the cash flows of costs and benefits over time a comparison of these figures in nominal values would cause serious distortions in the evaluation of a project. We must therefore consider the time value of money. This is most easily done by reducing the nominal values in terms of a common basis through discounting. Given this cash flows can be added, subtracted, etc.

1. <u>The net present value method</u>

The net present value (NPV) incorporates the time value of money for purposes of investment analysis. It expresses all expenses and expected earnings in terms of a base year, generally the first year of construction. The NPV approach measures the attractiveness of a project in monetary terms, but can adopt other forms as will be explained subsequently. The net present value of a risk free project represents the potential increase in net worth of an enterprise if it undertakes the investment. With risk present as is usual, the NPV expresses expected net benefits only. The calculation of the NPV requires the use of a predetermined discount rate [52, 56].

Curve BB' in quadrant I of Figure 1 represents the cumulative net benefits of a given project. On the vertical axis we have plotted as a positive magnitude the present value of the future net flows for given but different rates of discount. The initial cost of the project is represented by the distance OB. If we assume that the initial investment will take place in year zero, then its present value is given by the distance OC which equals OB.

Let us suppose that the initial rate of discount equals r_1, and that the period of production equals $t^* = n$. For this rate of discount the net present value equals PV_1. Observe that this value PV_1 represents the sum of the future net flows (FV_1, FV_2, ..., FV_n) discounted with respect to year zero since this corresponds to initial year of construction. The dotted line rr_1' represents the equivalent value of PV_1 when the future net flows are discounted for a period different from the year zero at the same rate of discount r.

In this case the net present value is given by the difference between the value PV_1 and OC. In other words by the distance PV_1, C. If we increase the rate of discount to r_2 the new present value equals PV_2 and the equivalent flow for different periods of discount are represented by the line r_2r_2'. For this alternative the net present value is determined by the difference between PV_2 and OC. That is to say the line represented by PV_2, C. One will observe that in the fourth quadrant the relationship between the rate of discount and the net present value to the extent that the rate of discount increases the net present value, will decrease. More specifically the tangent of the curve PV is negative.

Generally the present value of a given investment is given by the following equivalent algebraic expressions

$$NPV = \frac{B_1}{(1+r)} + \frac{B_2}{(1+r)^2} + \ldots + \frac{B_n}{(1+r)^n} \tag{2.1a}$$

$$NPV = \sum_{t=1}^{n} \frac{B_t}{(1+r)^t} \qquad t = 1, \ldots, n \tag{2.1b}$$

where

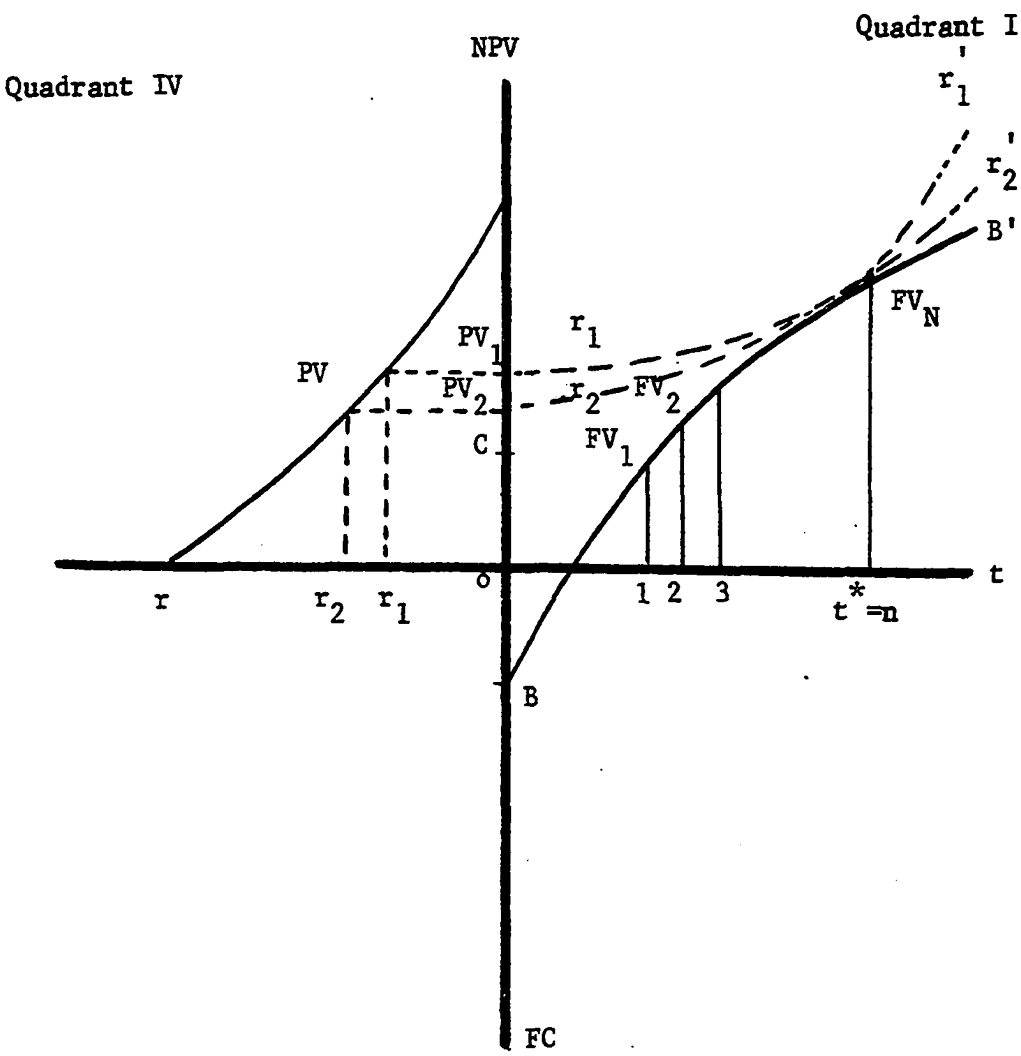


Figure 2.1. Graphical representation of the net present value method

NPV = the net present value of a given investment;

B_t = cash flow year t, that can be positive, negative, or zero;

r = the discount rate;

n = useful life of the investment.

With this method a project will result profitable when it fulfills one of the following conditions [60].

Condition I: When the net present value of the benefits is larger than the present value of the costs.

$$\sum_{t=1}^{n} \frac{B_t}{(1+r)^t} > \sum_{t=1}^{n} \frac{C_t}{(1+r)^t} \qquad t = 1, \ldots, n \qquad (2.2a)$$

Condition II: When the quotient of the present value of the benefits and the present value of the costs is larger than unity.

$$\sum_{t=1}^{n} \frac{B_t\,(1+r)^{-t}}{C_t\,(1+r)^{-t}} > 1 \qquad t = 1, \ldots, n \qquad (2.2b)$$

Condition III: When the actual valre of the annuity of the benefits exceeds the actual value of the annuity of the costs.

$$\sum_{t=1}^{n} (B_t - C_t)\,\frac{(1+r)^t - 1}{r(1+r)^t} > 0 \qquad t = 1, \ldots, n \qquad (2.2c)$$

Condition IV: When the internal rate of return of the project is larger than the rate of discount selected. That is to say, when i is larger than r, where i is given by:

$$\sum_{t=1}^{n} \frac{B_t - C_t}{(1+i)^t} = 0 \qquad t = 1, \ldots, n \tag{2.2d}$$

where

B_t = benefit year t,

C_t = cost year t,

r = discount rate,

b = constant annuity of the benefits,

c = constant annuity of the costs,

i = internal rate of discount, and

n = useful life of the project.

We must emphasize that the method of the net present value is sensitive with respect to the rate of discount selected. In practice it will not be easy to select the proper rate of discount. In Table 2.4 we present the average rate of return for different types of productive activities. These averages were calculated on basis of information obtained from references [65] and [58].

In Table 2.4 the average range of the rate of return for the types of business activities presented fluctuates between 4½ percent and 16½ percent. The selection of a specific value within this range as the appropriate rate of discount has a very substantial influence on the net present value.

In practice one frequently makes references to the following criteria in selecting an appropriate rate of discount [42, 50]:

1. the market rate of interest defined as the rate of return on relatively safe investments,

Table 2.4. Average return for types of enterprises

Type of enterprises	Average return on investment (percentage)
Business with stable earnings	4½ - 7½
Public utilities	5½ - 7½
Permanent business with small risk	5½ - 8½
Business with average risk	6½ - 11½
Temporal business	7½ - 13½
Business affected by climatic conditions	10½ - 16½
Business to be initiated	8 up
Business with high risk	12 up

2. the minimum rate of return as defined by the directors of the firm in question,
3. the fair rate of return as in regulated public utilities,
4. the average rate of return of a specific line of business activity,
5. the rate at which the firm can borrow capital.

The concept of the cost at which capital is available appears to be the most reasonable in setting the rate of discount. In generic form the cost of capital can be represented by the following formula:

$$\text{cost of capital} = [(r_d)(i_d) + (r_f)(i_f) + (r_b)(i_b)]/100 \qquad (2.3)$$

where

r_d = common stock as percentage of total capital,

i_d = average yield on common stock,

r_f = preferred stock as percentage of total capital,

i_f = average yield on preferred stock,

r_b = debenture bonds as percentage of total capital,

i_b = average yield on debenture bonds.

2. <u>The internal rate of return method</u>

We can define the internal rate of return as that rate of discount for which the present value of the benefits equals the present value of the costs [56, 64].

In Figure 2 we present a graphical representation of the internal rate of return. On quadrant I we have curve BB' which represents the accumulated net benefits of the project. On the vertical axis we measure the present value of the future net benefits for different rates of discount, indicated as PV. On the other hand the initial investment is indicated by the distance OB. Assuming that investment is undertaken during year zero, its present value is given by the distance OC which equals OB.

Given that the useful life of the project equals $n = t^*$ and given a rate of discount equal to r^* we then discount the net benefits so as to obtain their equivalent present value. Because of this the distance PV^* equals OC. It will be seen therefore that r^* represents the internal rate of return because as can be seen in quadrant IV at point A the net present value is equal to zero because $PV^* - OC = 0$. Similarly it follows that the values of net present value beyond point A are positive and below point A they must be negative.

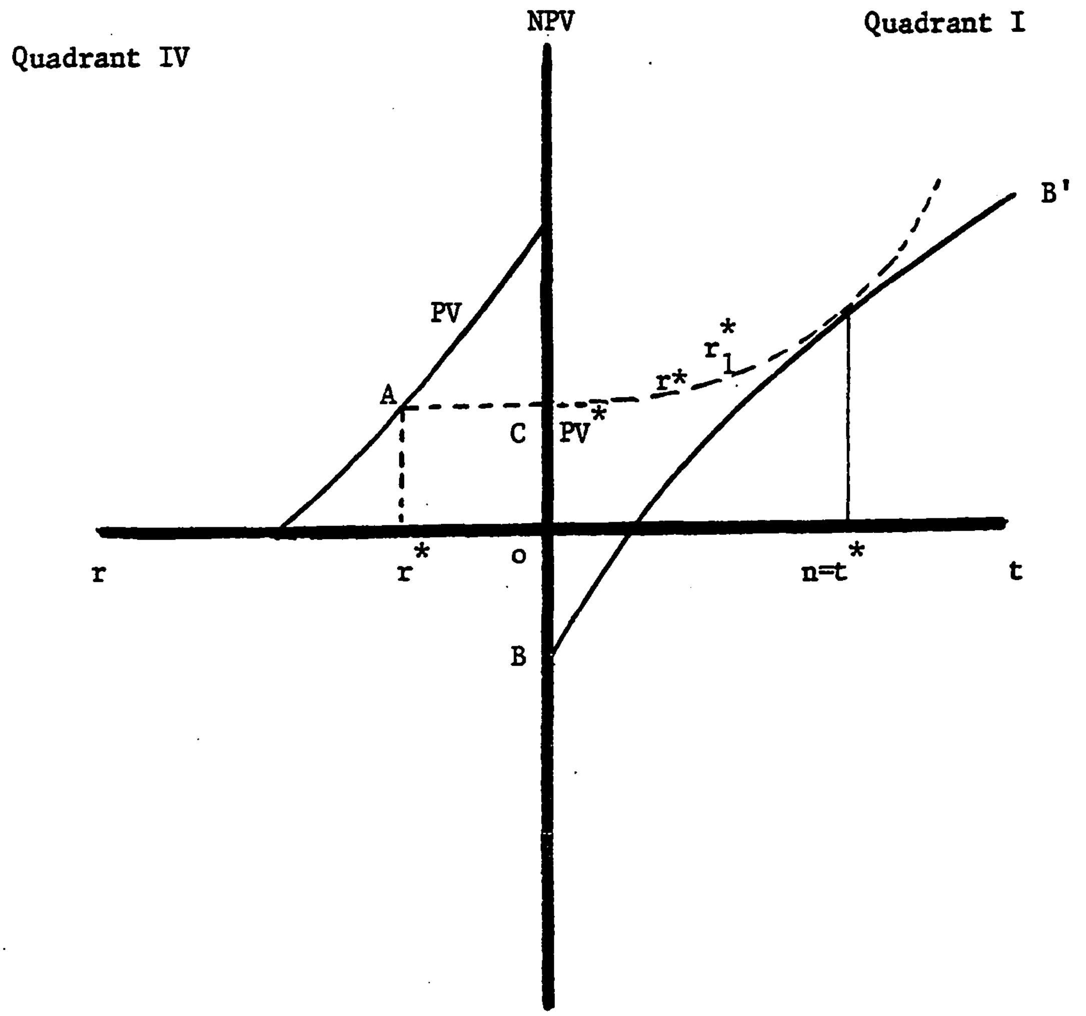


Figure 2.2. Graphical representation of the internal rate of return

The dotted line r^*, r_1^* represents the equivalent present values equal to PV^* when the future net flows are discounted for a period of production with a starting point other than year zero. In practice the procedure to find the internal rate of return is by means of an iterative process. For example one may select an initial rate of discount and one compares the benefits and cost obtained. In case there are differences one then utilizes a larger or smaller rate of discount until the differences have been reduced to zero. Generally the internal rate of discount can be defined by means of the following equivalent expressions:

$$\frac{B_1}{(1+i)} + \frac{B_2}{(1+i)^2} + \ldots + \frac{B_n}{(1+i)^n} = 0 \tag{2.4a}$$

$$\sum_{t=1}^{n} \frac{B_t}{(1+i)^t} = 0 \qquad t = 1, \ldots, n \tag{2.4b}$$

where

B_t = cash flow year t, that can be positive, negative, or zero;

i = the internal rate of return;

n = useful life of the investment.

The project selection rule given by this method implies that one will look for that project which has the highest rate of return, given of course that this rate of return is larger than the rate at which the enterprise must borrow the capital so invested. In other words the internal rate of return can be interpreted as the maximum rate of return which a firm can allow itself to be paid in financing an investment without losing money. This approach is appropriate when the investment alternatives are independent, such that their nature and objectives do not compete with each other.

When one has to evaluate projects which are substitutes for one another in the attainment of a similar objective then the most satisfactory way of applying the internal rate of return method is in terms of increments in the net flows of capital involved. This variant consists in ordering the projects according to the initial investment requirement starting with the least costly alternative. One then compares the projects on a pairwise basis, always maintaining the most favorable alternative. This alternative serves as the base of comparison until some other alternative comes out better or until no more projects are to be considered.

In Table 2.5 we present an example of the use of the internal rate of return method when we have projects which may substitute for one another. We assume first that the minimum rate of return can not be less than 15 percent. When we compare alternative II and I we observe that the marginal rate of return equals 12 percent. Since this rate of return is less than the minimum acceptable rate of return, we eliminate alternative II. We then proceed by comparing alternative III with alternative I and obtain a rate of return equal to 13.1 percent. This eliminates alternative III.

One may appreciate from column I that no alternative generates a return larger than 15 percent. Hence alternative I is the most favorable one. Let us assume that the firm considers that the minimum acceptable rate of return must lie within the range given by 10 percent and 15 percent. In this case when we compare alternative II and I we obtain the marginal rate of return equal to 12 percent. Since this value falls within the acceptable range given for the minimum acceptable rate of return we eliminate alternative I.

Table 2.5. The internal rate of return method (IRR) applied to mutually exclusive alternatives

Alternative	First cost	Annual net cash flow	Overall IRR	IRR on incremental investment over: I	II	III	IV
	(dollars)		(percentage)				
I	6,000	660	11.0				
II	7,500	840	11.2	12.0			
III	9,000	1,053	11.7	13.1	14.2		
IV	10,500	1,323	12.6	14.7	16.1	18.0	
V	12,000	1,500	12.5	14.0	14.6	14.9	7.0

When we compare alternative III and II we obtain a return of 14 percent which eliminates alternative II. Then we consider alternative IV which has a rate of return of 18 percent. But when we compare alternative V and IV we observe that the rate of return is 7 percent less than that specified in the minimum acceptable rate of return. Hence alternative IV is the most favorable alternative in this particular case.

One should observe that this process depends on the definition and on the specification of the minimum acceptable rate of return. Nevertheless we must mention the internal rate of return method may fail under certain circumstances, that is, the results produced may be ambiguous. In Figure 3 we present four graphs which present the possible results of the use of the internal rate of return method. For these purposes we measure on the vertical axis the net present value of the project and on the horizontal axis the rate of discount.

In Figure 3.a we have the conventional result where r represents the internal rate of return. This result is characteristic when one compares an initial investment followed by a flow of benefits. In Figure 3.b the internal rate of return method does not give us a unique result. One will appreciate that the internal rate of return is given simultaneously by r_2 and r_3. This case will generally present itself when a project requires large additions of capital during its useful life.

In Figure 3.c it is impossible to determine a value for the internal rate of return. This is due to the fact that the benefits are so large that for no rate of discount will the present value equal that of the present value of the costs. Finally in Figure 3.d we have a case somewhat similar to the above mentioned one, except that the initial investment is very large. Because of this the net present value is always negative.

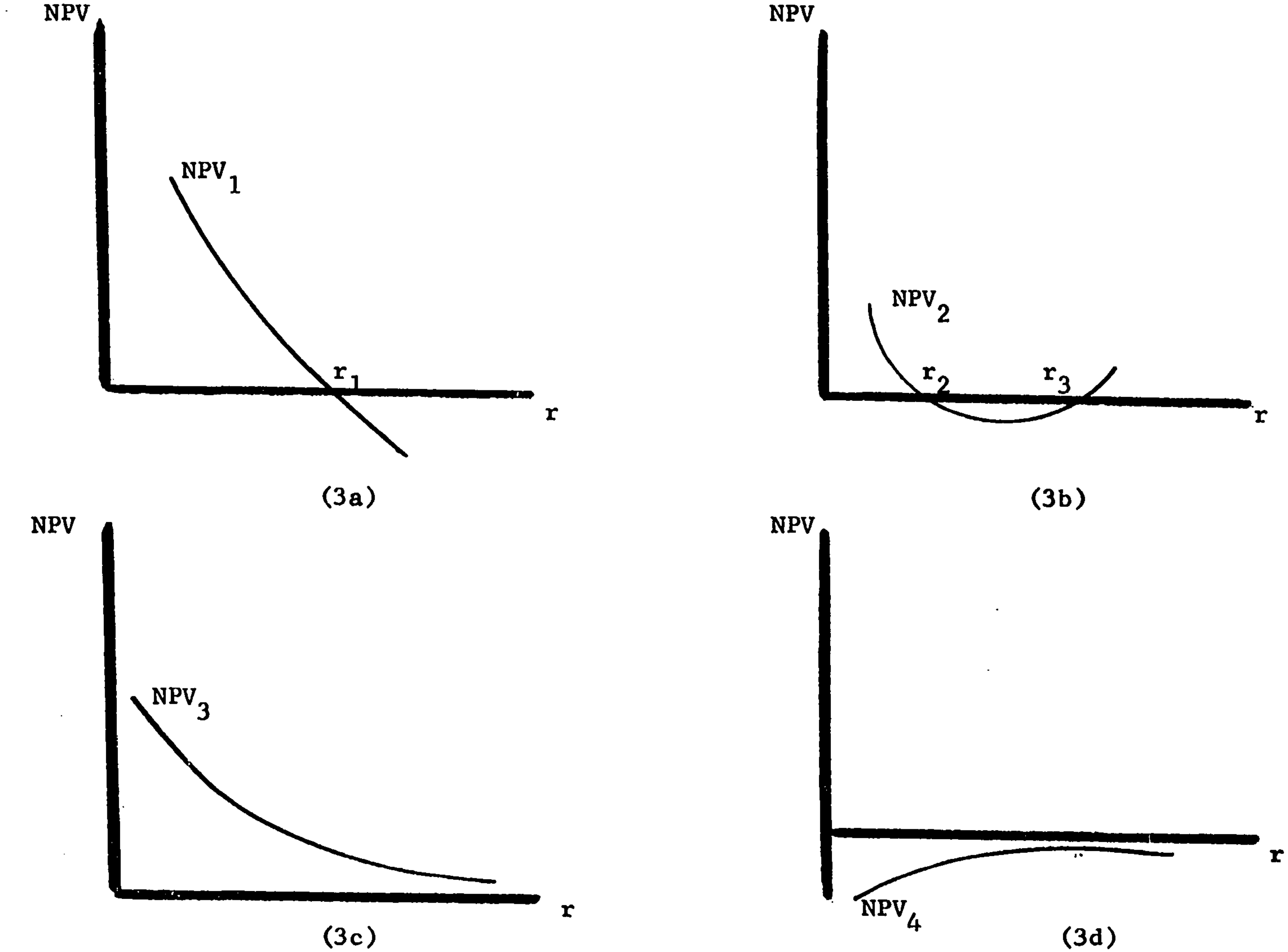


Figure 2.3. Possible results of the internal rate of return

III. THE CONCEPTUAL BASIS OF COST-BENEFIT ANALYSIS

The objective of this section is the analysis and the development of the conceptual basis which underlies the cost-benefit criterion. Initially we will take as a point of reference the model of perfect competition. Subsequently we will revise the basic assumptions made with respect to consumer and producer behavior and with respect to the structure of the economic factor and product markets. Given these assumptions we then derive the optimality conditions for the efficient allocation of resources and the maximization of consumer utility and producer profits. Given this situation one can demonstrate that the benefit-cost criterion is a restatement of the first order optimality conditions of the perfectly competitive model.

In these conditions the distribution of resources as based on market prices for commodities and production factors will result in Pareto optimality for a given income distribution. In other words market prices of goods and factors would equate and equal the marginal social cost of producing and the marginal social benefit of using these goods and factors of production. Consequently the money value of outputs and inputs at market prices must be the representative figures of the benefits and costs of the marginal project.

In the case of well-developed economies one may assume that the market prices are acceptable approximations for equilibrium prices as would be theoretically derived from a model of perfect competition. In this sense the prices actually observed reflect the opportunity cost of the factors of production. Consequently the evaluation of a change in economic structure in terms of costs and benefits can be done using the market prices. On the other hand the prevailing economic environment in developing economies is significantly different from the conditions associated with the model of perfect competition. In this sense one must take into account a series of market imperfections which a priori prohibit the possibility of satisfying the equilibrium conditions required for the optimal distribution of resources.

Commonly such disequilibriums are associated with distortions which may arise in factor markets due to monopolistic and monopsonistic elements, price controls, the institutional determination of salaries and wage rates, etc.

Under these conditions the actually observed prices do not reflect the real opportunity cost of the factors. Should one use such prices nevertheless the resulting distribution of resources would become inefficient. That is to say, market prices will not reflect the social costs and benefits of using and producing different commodities. Given this situation the problem reduces itself to the necessity of making an adjustment in the observed market prices. Such adjustments will result in shadow prices which can be presumed to reflect the real social opportunity cost of the factors of production.

Consequently in the evaluation of a change in the economic structure one will then use the shadow prices so calculated. Obviously the determination of shadow prices are to some extent dependent on the specific circumstances of the economic environment within which the project is to proceed.

A. Perfect Competition, Market Imperfections, and Cost-Benefit Analysis

We may safely state that cost-benefit analysis is closely linked with the principles of the theory of welfare economics. In this sense we can interpret cost-benefit analysis as a specific application of the theory of income distribution based on the so-called principles of compensation or more specifically that of a potential Pareto improvement [57].

Initially we will discuss the problem of resource distribution with respect to a purely competitive economy where all resources are privately owned. The solution of the model so obtained represents a social optimum and we will detail the assumptions necessary for such a solution to be achieved.

With respect to the consumer we make the following assumptions. First the consumer must be rational in the sense that his preferences are consistent and well-defined. Second the preferences of each consumer are independent of all other consumers. Consequently the utility function of each consumer is not affected by the change in the utility pursued by any other individual. Thirdly, the utility function for each consumer must reflect a decreasing rate of commodity substitution among goods. Also the consumer must be supposed to look for the maximum amount of utility possible for given income.

With respect to the assumption of the behavior of the producer we consider that each producer will try to maximize profits. Production must be carried out under conditions of decreasing marginal returns. We also assume the absence of externalities of either the technological or pecuniary kind.

Finally the assumptions with respect to the structure of the economies factor and product markets are the following: there must exist perfect information with respect to the prices and commodities; every market has so many buyers and sellers that nc single trader has any control over the price of the good or service which is being exchanged. Additionally it must be assumed that all available resources are fully employed.

Finally, the optimality of the competitive model assumes that the resultant distribution of income is appropriate and constant over time. In this form, the distribution of resources, in a perfectly competitive economy on the basis of market prices will result in Pareto optimality for a given distribution of income.

The technical conditions necessary for the existence of a Pareto optimum are as follows: the marginal rates of substitution of any pair of commodities must be the same for all individuals consuming both goods. The marginal rates of substitution between any pair of factors must be the same in all industries in which they are used. The marginal rates of transformation in production of different goods must be equal to their marginal rates of substitution in consumption.

Given these conditions production and distribution cannot be reorganized to make one individual better off without making someone else worse off [34].

Given an investment project, the values of the outputs and inputs at market prices would then provide the relevant costs and benefits figures to be used in determining the net present value of the project. Individual firms produce up to that point where price equals marginal cost, where costs are determined by the technical conditions of production and by factor prices. The latter reflect the predisposition of consumers to supply these factors and their value in the production of other goods.

In equilibrium the consumer will distribute his income in such a manner that the marginal rates of substitution are equal to relative prices. In this sense the benefit of a commodity is equal to the price that the consumer pays. Taking benefits equal to prices paid we can as in Eckstein [17] state that the firm should produce up to that point where marginal costs equal marginal benefits.

Expressed in a different manner, the marginal conditions imply that in equilibrium the benefit-cost ratio equals unity.

Let us suppose that we have a marginal project with respect to the national economy. The production function of the project is represented by:

$$K(Y_1, \ldots, Y_k, Y_\ell, \ldots, Y_n) = 0 \tag{3.1}$$

where:

$Y_1, \ldots, Y_k$ = quantities of products and

$Y_\ell, \ldots, Y_n$ = quantities of factors.

In addition we define a change in social welfare in terms of national income units. Where national income is defined to include the negative values of factor services. Then we can write:

$$\Delta W = \sum_{i=1}^{n} P_i \, \Delta Y_i \qquad i = 1, \ldots, k, \ell, \ldots, n \tag{3.2}$$

The increase in social welfare is maximized by maximizing the following relation:

$$Z = \sum_{i=1}^{n} P_i \, \Delta Y_i - \lambda K \, (Y_1, \ldots, Y_k, Y_\ell, \ldots, Y_n) \tag{3.3}$$

The first order conditions are given by:

$$P_i - \lambda \frac{\partial K}{\partial Y_i} = 0 \tag{3.4}$$

If we define the benefits and costs of an investment project as:

$$B = P_1 \, \Delta Y_1 + \ldots + P_k \, \Delta Y_k \tag{3.5a}$$

$$C = P_\ell \, \Delta Y_\ell + \ldots + P_n \, \Delta Y_n \tag{3.5b}$$

where:

$\Delta Y_1, \ldots, \Delta Y_k$ = changes in outputs and,

$\Delta Y_\ell, \ldots, \Delta Y_n$ = changes in inputs.

Then, we can express the change in welfare function in terms of benefits and costs by:

$$\Delta W = B - C \tag{3.6}$$

In this way, relation (3.3) turns into:

$$Z^* = B - C - \lambda K\,(Y_1, \ldots, Y_k, Y_\ell, \ldots, Y_n) \tag{3.7}$$

The first order conditions becomes:

$$\frac{\partial B}{\partial Y_i} - \lambda \frac{\partial K}{\partial Y_i} = 0 \qquad i = 1, \ldots, k \tag{3.8a}$$

$$\frac{\partial C}{\partial Y_s} - \lambda \frac{\partial K}{\partial Y_s} = 0 \qquad s = \ell, \ldots, n \tag{3.8b}$$

Which implies that the marginal benefits are equal to the marginal costs.

$$\frac{\partial B}{\partial Y_i}\;\frac{\partial Y_i}{\partial K} = \frac{\partial C}{\partial Y_s}\;\frac{\partial Y_s}{\partial K} \tag{3.9}$$

Or alternatively, the benefit-cost ratio equals unity.

$$\frac{\partial B}{\partial C} = 1 \tag{3.10}$$

We said before that the system prices in a well-developed economy can be taken as a first approximation with respect to the prices which would exist in a model operating under perfect competition. In this sense the distribution of resources given the incentives provided by market prices is also an efficient distribution.

On the other hand, in under developed countries one frequently finds a series of market imperfections. This implies that actual market prices do not reflect the true opportunity cost of factors of production. In these circumstances the immediate application of actual prices must necessarily conduce to a continuation of the misallocation of resources.

One of the restrictions frequently found in developing economies is the small size of the market. This implies that only a small number of firms can operate the size of the plant and level of production as required in a model of perfect competition. Under such conditions the firms can expand the volume of production and thereby reduce their unit costs of production. That is to say such firms operate in a range of decreasing average costs. This situation is conducive to the creation of an oligopolistic or monopolistic market structure, with its associated pricing policies. One may expect that on both sides of the market certain imperfections will exist which have an influence on the determination of the price at which goods are sold and bought.

Also the obvious interdependence of production processes create certain diseconomies of scale which reflect themselves in the productivity and efficiency of the firms. Also the assumption of perfect resource mobility is questionable. Furthermore the limited amount of information about prices and market organization imply that producers and consumers to a lesser or greater extent cannot efficiently allocate their available resources. The reduced size of the market, surplus labor, and capital rationing militate against the most efficient use of resources. The optimality conditions of the competitive model assume that the associated income distribution is appropriate; this assumption is not shared with those who are familiar with the great inequality of incomes in lesser developed countries.

Given these reasons, the observed market prices do not reflect the true opportunity cost of resources and outputs. What is needed is a systematic adjustment in such prices, particularly for strategic inputs like capital, labor and foreign exchange.

B. The Social Rate of Discount

We observed previously that the rate of discount was an important parameter in relation to investment decisions. From the point of view of the single competitive firm the appropriate rate is that at which capital can be borrowed. This principle also holds for public investment. An inappropriate choice of the rate of discount leads to a sub-optimal selection of investment projects. In particular a low rate of discount will favor capital intensive projects of long duration.

With respect to Peru the available feasibility studies do not try to justify the choice of the rate of discount on a theoretical basis, it seems to be selected arbitrarily. With well-organized capital markets one or the other market rate of interest can be taken as a point of reference. But even then such rates will not necessarily be representative of the consumer rate of discount. Ideally these two rates of discount should be equal to one another. Similarly the market rate of interest does not necessarily correspond to the rate of interest received by the representative firm. Ideally a firm should invest up to that point where the marginal efficiency of capital equals the market rate. Or in a static context, the marginal rate of transformation between current and future output flows should equal the market rate of interest.

Since the capital goods, and inputs markets are subject to substantial imperfections in the lesser developed countries we should develop methodologies that allow us to adjust for this. Generally speaking there are two ways of doing this [26, 49]. On the one hand one can define the concept of the social opportunity cost of capital (SOC). It measures the value which society foregoes if it were to use the funds designated for public sector use for private sector use instead. The chronological rate of time preference (STP) takes into account the relative valuation which society assigns to consumption at different periods of time.

In the following pages we will briefly review the theoretical arguments for both of these concepts, and their relevance for project evaluation.

1. Social opportunity cost

The social opportunity cost concept addresses itself to the question as to whether resources currently being employed in the private sector should be assigned to the public sector [30]. But there is no single representative rate of return of capital in the private sector. Typically therefore the concept of social opportunity cost is made to refer to the marginal productivity of capital as between economic branches of activity. The marginal productivity of capital serves as substitute concept for the internal rate of return of investment projects. Given differential taxation procedures throughout the private sector, the internal rate of return can be estimated in two ways. One can calculate the rate of return before taxes or one can consider taxes paid as indirect benefits. However, other distortions influence this computation, such as the effective degree of tariff protection. To allow for this one could price the factors of production and intermediate inputs used at border prices.

Generally therefore the estimation of the social rate of discount should be based on the following considerations. One should identify the different sectors that participate in the realization of the public sector project. In this manner the social rate of discount will reflect a weighted average of the representative sectorial internal rates of return [7]. This allows us to write the SDR as follows:

$$\begin{aligned} SDR = & \sum^{s} \sum^{j} a_{sj}\, i(c)_{sj} + \sum^{k} \sum^{j} b_{kj}\, i(I)_{kj} \\ & + \sum^{h} \sum^{j} c_{hj}\, i(K)_{hj} \end{aligned} \tag{3.11}$$

where:

a_{sj} = percentage participation of enterprise j in the production of consumption good s, used in the public sector project,

$i(c)_{sj}$ = the rate of internal rate of return of enterprise j in the production of consumption good s,

b_{kj} = percentage participation of enterprise j in the production of intermediate good k, used in the public sector project,

$i(I)_{kj}$ = the rate of internal rate of return of enterprise j in the production of the intermediate good k,

c_{hj} = percentage participation of enterprise j in the production of capital good h, used in the public sector project and,

$i(K)_{hj}$ = the rate of internal rate of return of enterprise j in the production of capital good h.

The proper estimation of the social rate of discount requires therefore very detailed information which in practice is not usually available. Furthermore, in the lesser developed countries most of the capital goods will have to be imported. This represents a methodological difficulty which is not easily surmounted, unless one assumes the relevance of external rates of return to an internal situation.

Alternatively one may prefer to work with a market rate of interest, usually the rate of interest on long term public sector bonds. The argument in favor of this procedure is [63] that such a rate reflects the cost of borrowed capital used in financing the project. It assumes that such bonds are essentially risk free [70, 73]. Given the inflationary environment of many lesser developed countries and the possibility of unilateral rescheduling of the internally held public debt such an assumption is not warranted. Furthermore such issues are not generally sold throughout existing capital markets. Often they are imposed upon the banking system by decree.

2. The social time rate of preference

The social time rate of preference rejects the theoretical approach of social opportunity cost. The arguments are as follows: Given multiple markets imperfections and rates of interest it is impossible to select a single rate of interest which reflects both the time rate of preference and the marginal productivity of capital [26]. The STP method therefore determines the social rate of discount in relation to the value that society assigns to consumption in different periods of time. The problem consists in finding over time a convergence between individual and social decisions as to how much to consume, save and invest. Such a convergence is equivalent to a proper weighting of the consumption enjoyed by successive generations.

Taking into account uncertainty and the finite life horizon of the individual it is reasonable to assume that the flow of income generated during his life will be distributed in favor of current consumption. Moreover the existence of capital markets allow the individual to convert at will long term financial instruments in current consumption. Because of this the individual preferences of the present generation are in conflict with the potential level of consumption of future generations. Marglin [49] considers three situations which can be used to define the social time rate of preference. Prest and Turvey also take a similar approach [60].

Marglin first considers the situation where individual preferences give a higher weight to present consumption, in conflict with the interest of future generations. The competent authorities in order to preserve the interest of future generations will coerce the present generation to observe the proper level of savings. It can be enforced through the market mechanism. This approach known as authoritarian, is rejected by Marglin.

A second approach is known as schizophrenic. Economic men have two preference mappings. One represents their individual preferences and the other their preferences as members of society, reflecting concern for the welfare of future generations. The proper rate of interest differs between these two preference mappings and is therefore undeterminable.

In order to solve this problem Marglin suggested that the planning authorities reconcile the interests of present and future generations. Such intervention is necessary because the market mechanism reflects individual preferences only. The emphasis to be given to future generation welfare is a political decision.

In order to better understand the concept of the social time rate of preference we can take Irving Fisher's indifference curve analysis of private investment decision making [26]. The solution obtained is valid for a two period analysis. We first analyze such a decision from the individual's point of view, and then extend it to the field of public investment.

In Figure 4 we represent along the two axis the quantities consumed in the respective time periods. The individual initially consumes OA_4 units in period t, and nothing in period t+1. That decision has a corresponding location on the indifference curve U_2. Line B_5A_4 represents the borrowing-lending possibility curve. The slope of this line equals the rate of interest plus one. The individual can distribute his consumption between the two periods by moving along this curve. Point B_5 indicates a position where the individual consumes OB_5 units in period t+1 and nothing in period t. This option will result in a position on the lower indifference curve U_1.

We assume that the only form of redistributing consumption between the two periods is through borrowing and lending. The individual will reach his preferred position at point X_4. He will borrow A_4A_2, consuming OA_2 in period t, and OB_1 in period t+1, a decision which locates him on indifference curve U_3.

Curve A_4B_6 represents the investment possibilities. The slope of this line is the marginal efficiency of capital. The rate of transformation of present goods into future goods decreases as the volume of investment increases.

According to the principle of net present value or the internal rate of return, the investor will invest A_4A_1 as indicated by point X_1. At this point the marginal efficiency of capital is equal to the rate of interest. In this situation the investor will consume OA_1 in period t, and OB_4 in period t+1. The utility level attained is indicated by the indifference curve U_4. The present value of the consumption in the two periods, represented by point X_1 equals OA_6.

If the investor invests an amount A_4A_3 then the marginal efficiency of capital will equal the marginal rate of substitution between consumption in period t and t+1. The investor's decision locates him in point X_2, corresponding to the indifference curve U_5. In this position he will consume OA_3 in period t and OB_3 in period t+1.

If the investor follows the rule of maximizing the internal rate of return he can achieve a position on indifference curve U_6. At point X_3 he will invest A_4A_1, borrow A_1A_5, consume OA_5 in period t and OB_2 in period t+1.

In case of public investment curve B_6A_4 represents the social productivity of investment. The indifference curves U_1, ..., U_6 represent two period social time preference indifference curves. The slope of these indifference curves represent society's marginal rate of substitution of present for future goods.

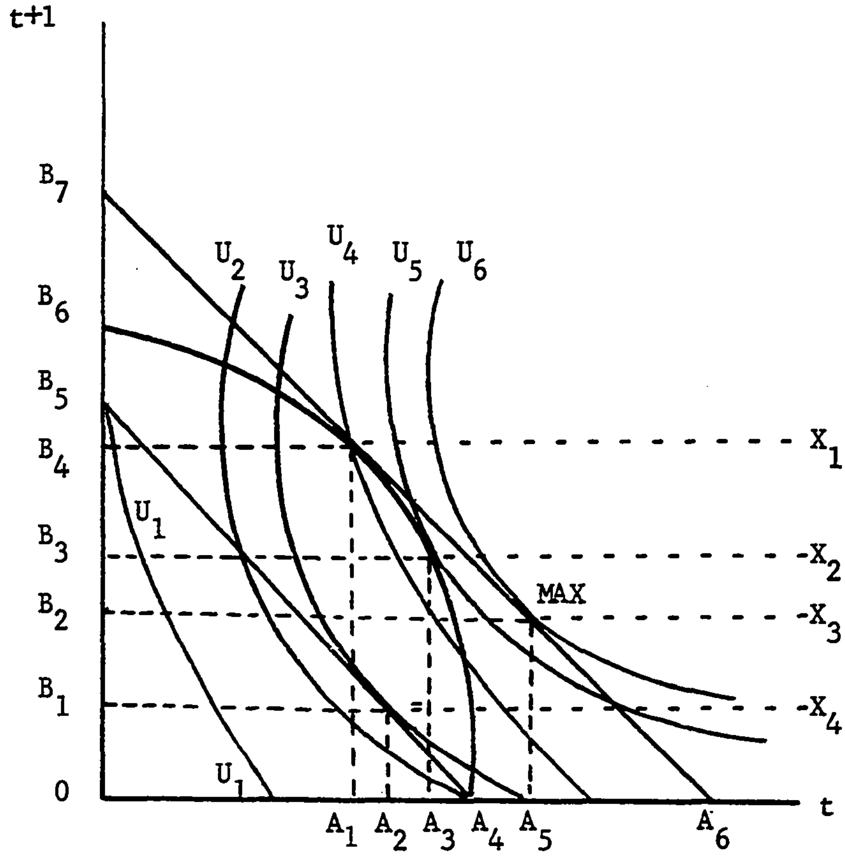


Figure 3.1 The graphical approach to the derivation of the social time preference function

C. The Shadow Price of Labor

In a perfectly competitive model the wage rate will equal the marginal value productivity of labor. In the lesser developed countries the prior condition of perfectly competitive markets does not exist. Actual wage rates may be determined by custom, by law or through collective bargaining. Typically the actual wage rate will be larger than its marginal value productivity, especially in agriculture. This allows for additional employment. Such additional employment, beyond that implied in the perfectly competitive model, is called disguised unemployment. Often the additional assumption is made that the productivity of such labor is close to zero [45].

The social opportunity cost of employing such labor is then zero or in any case below the existing market wage. This loss in productivity (m) serves as a first approximation of the shadow wage rate.

$$SWR = m \tag{3.12}$$

In order to mobilize the labor necessary elsewhere the offered wage (s) must be larger than the previous wage (m). The difference (s-m) can be interpreted as an additional allocation for consumption purposes. Consequently (3.12) can be rewritten as

$$SWR = m + (s-m) \tag{3.13}$$

But not all of this increase in consumption represents a social cost, because society values P units of consumption as equivalent to one unit of savings. In order to determine the net social cost of this increase in consumption a fraction 1/P must be subtracted. Expression (3.13) then becomes

$$SWR = m + (s-m) - (s-m)/P \tag{3.14}$$

One should also allow for changes in the disutility of work (D) associated with the mobilization of labor for purposes of the project. Such changes are compensated for when the utility maximizing worker gives equal weight to the disutility of additional work and the additional utility possible through work. Hence the disutility of additional work (D) equals the change in consumption (s-m) and its value in terms of savings equals $\alpha(s-m)/P$, where α represents the weight society gives to this disutility.

If we assume that the wage rate paid by the project is institutionally determined and larger than the market wage rate w, then the net change in the disutility of work equals (s-m) - (s-w) or (w-m). This allows us to write a general formula of the social opportunity cost of work.

$$\begin{aligned} SWR &= m + (s-m) - (s-m)/P + \alpha(w-m)/P \\ &= s - (s-m)/P + \alpha(w-m)/P \end{aligned} \tag{3.15}$$

where:

m = production foregone,

s = wage rate paid by the project,

P = the price of social income foregone in terms of consumption and

w = market wage

If with Lewis [45] we assume that the marginal productivity of labor equals zero, then m equals zero. Similarly the wage rate of the project, according to Lewis must be at least equal to the average product per worker in the traditional sector. In practice the observed gap in wage rates between the modern and traditional sector equals 30 percent [51].

If we assume that society does not value the loss of leisure ($\alpha=0$) and if the savings/consumption rates are optimal ($P=1$) then the shadow wage rate equals the marginal product of labor. This equals zero in Lewis's case.

Harberger [30] argues that the social opportunity cost of labor must reflect the actual wage rate. If the project takes place in a rural area then the appropriate wage rate is that wage rate at which workers can be obtained. In case the project is located in an urban area an additional premium above the existing wage rate may be necessary in order to induce rural labor to migrate to urban areas. The shadow wage rate is therefore always larger than zero. Assuming that the individual rationally allocates his time between leisure and work, one should start with the assumption that $\alpha=1$.

Little and Mirrlees [46] sustain that the shadow wage rate must be different from the market wage. The social opportunity cost of work should reflect the additional resources channelled towards additional consumption, directly and indirectly. Additional employment implies certain beneficial externalities, such as improved health and nutrition, etc.

ONUDI [14] also sustains that the actual wage rate is not an appropriate measure for the social opportunity cost of labor, in particular under circumstances of surplus labor. According to ONUDI [14] the shadow wage rate can be decomposed into three elements. The first element refers to the direct opportunity cost. It is to be understood as the social valuation of the marginal product foregone when a worker is employed by the project. This component appears as the element m above.

The second element tries to capture the indirect effects in terms of its effect on the savings rate. Generally a large discrepancy between the actual wage received and the marginal productivity will imply a lesser savings rate. It assumes that workers have a very high propensity to consume.

The third element that should be included in estimating the shadow wage is the income redistributive effect of the project. The weight attached to this depends on the societal importance of investment foregone, and consequently future employment opportunities foregone. Consequently the shadow wage rate may exceed exceed the actual wage rate, given a sufficient importance of these indirect effects.

D. The Shadow Price of Foreign Exchange

Foreign exchange is often rationed in lesser developed countries. The quoted exchange rate therefore does not reflect a rate established through the free interplay of the demand for and supply of foreign exchange. Tariffs, quotas and other import restrictions also distort the internal price structure.

In the traditional two goods-two factor international trade model, the optimal pattern of production and trade is given by the tangency of the domestic production possibility frontier and the terms of trade line. Consumption is determined by the tangency of the same trade line and the highest social indifference curve. Maximum welfare is obtained when the marginal foreign rate of transformation equals the marginal national rate of transformation and the marginal rate of substitution of the two goods. The relevant prices of the two goods are given by the international prices of the two goods. The relative factor prices are then also determined according to Samuelson's theorem [62].

The earlier mentioned restrictions create a disequilibrium between the relative prices between traded and nontraded commodities. The use of market prices in evaluating a changing output mix brought about by a project is therefore wrong. The current literature adjusts for these discrepancies by either taking the foreign currency prices of the commodities and using a shadow exchange rate to calculate the shadow prices of commodities [2, 9] or alternatively use the foreign currency as the numeraire. In that case the foreign currency prices of the commodities will be the relevant shadow prices [46].

We first discuss the approach which expresses the shadow prices of the goods and services in domestic currency. Harberger [30], Fontaine [27] and the UNIDO [14] suggest that the foreign exchange shadow price should reflect the value of an additional dollar in terms of social welfare, where welfare is measured in national income units. It assumes that the economy is in equilibrium. The valuation of benefits and costs are based on welfare measuring shadow prices. These shadow prices are the result of corrected input and output prices associated with the project, taking into account the relevant shadow exchange rate.

If the project yields a net benefit, using above shadow prices, then the project is socially attractive. The shadow exchange rate can be expressed as follows:

$$SER_{uhf} = \frac{r\,(\sum_{i=1}^{n} T_i\, W_i\, dM_i - \sum_{j=1}^{m} S_j\, W_j\, dX_j)}{\sum_{i=1}^{n} W_i\, dM_i - \sum_{j=1}^{m} W_j\, dX_j} \tag{3.16}$$

where:

r = market exchange rate,

T_i = effective tariff for import i,

W_i = (constant) world price for import i,

dM_i = marginal change in imports induced by the project ($i = 1, \ldots, n$),

S_j = export tax or subsidy for export j,

W_j = (constant) world price for export j, and

dX_j = marginal change in exports induced by the project ($j = 1, \ldots, m$).

This procedure can be criticized in the sense that only marginal changes in imports and exports of currently traded goods are taken into consideration.

Bruno [9] and Krueger [44] suggest that the foreign exchange shadow price should reflect the opportunity cost of a dollar in other uses. For an economy beset with balance of payments problems, the cost of producing foreign exchange can be used as a resource allocating criterion. In this sense it represents a measure of the opportunity cost of domestic resources in saving or creating an additional unit of foreign exchange. If this cost is less than the shadow foreign exchange rate, then the project is socially attractive. Following Bruno we have

$$CFE_{bk} = \frac{\sum_i a_{ij} P_i + \sum_s b_{sj} P_s}{X_j - M_j} \tag{3.17}$$

where:

a_{ij} = input of primary factor i per unit of output j,

P_i = price of primary factor i,

b_{sj} = input of good s per unit of output j,

P_s = price of good s,

X_j = foreign exchange revenue per unit of output j and

M_j = foreign exchange loss per unit of output j.

The first term in the numerator is the value added of the primary factor of production. The second term measures the value of nontraded domestic inputs. The denominator measures the net foreign exchange attributable to the production of j.

Bacha and Taylor [2] propose that the foreign exchange shadow price should be the equilibrium exchange rate, defined for an economic environment without international trade distortions. It allows for a readjustment in imports and exports as related to foreign international trade. The essential condition for its application implies that the product of the effective tariff and the official exchange rate not exceed the equilibrium exchange rate of the economy. The equilibrium exchange rate is calculated as follows:

$$E_{bt} = \frac{r\ [\sum_i S_i(X_i E_i^x)\ \sum_j T_j(-M_j E_j^m)]}{\sum_i X_i\ E_i^x - \sum_j M_j\ E_j^m} \tag{3.18}$$

where:

r = official exchange rate,

S_i = tax or subsidy on i^{th} export,

X_i = share of sector i in total exports,

E_i^x = price elasticity of export supply of the i^{th} good,

T_j = tariff on the j^{th} good,

M_j = share of sector j in total imports and,

E_j^m = price elasticity of import demand of the j^{th} good.

Little and Mirrlees [46] take the foreign currency as a numeraire In that case the foreign currency prices of the domestically produced goods will be the relevant shadow prices. Little and Mirrlees distinguish two steps. In the first step one identifies the tradeable goods, valued at world prices. Nontradeable goods are also valued at international prices by using conversion coefficients. Subsequently the cost of labor is valued at a shadow wage rate, as previously explained.

IV. SOCIAL INVESTMENT CRITERIA FOR PROJECT EVALUATION

In this chapter we will develop and will analyze the criteria currently accepted as a basis for a social evaluation of projects.

Initially we present the method proposed by Marglin, taking as a starting point the traditional analysis. Given this, we make all the necessary adjustments in order to obtain a general formula that represents Marglin's approach. Subsequently we derive the method proposed by Little and Mirrlees, maintaining the assumptions utilized in the derivation of Marglin's method. Then we compare both methods, pointing out their basic similarities and differences.

Later on we present the method proposed by Chenery. In this section we include several criticisms and commentaries made by well-known economists according to their results in the application of this method. Finally we develop the semi input-output method, including some possible extensions of the original method.

A. Benefit-Cost Analysis

Benefit-cost analysis is undoubtedly the best known and utilized method in evaluating investment projects. Even though there exist variations in the formulation and application of this method, all of them have a common objective, i.e. the degree of economic, financial and/or social attractiveness of an investment project. The common characteristic of the different formulations of benefit-cost analysis stems from its interrelation with the theory of economic welfare. Benefit-cost analysis is therefore conceived as an application of resource allocation theory and the compensation principle [57]. If the sum of the compensated variations of the gainers exceed the compensated variations of the losers then the sum of the compensated variations is considered as a potential Pareto improvement. The benefits can be distributed as to make everyone concerned better off.

In the preceding chapter we verified that benefit-cost analysis represents a restatement of the first order optimality conditions of the perfectly competitive model. In this section we compare and analyze the methodological variants of benefit-cost analysis, i.e. ONUDI [14] method and OCDE [46] method. Both will be applied subsequently in relation to the portfolio of projects considered for this thesis.

In Chapter II we reviewed benefit-cost analysis in reference to a decision maker in the private sector. In that case the attractiveness of the project depended on the surplus between discounted monetary revenues and expenditures. The index of profitability was given by relation (2.1) which can be written as:

$$B = \sum_{t=1}^{n} \frac{B_t}{(1+i)^t} - K_o \tag{4.1}$$

where

B_t = net revenue in year t,

K_o = initial investment,

i = the rate of discount and,

n = the life of the project (t = 1, ..., n).

The benefits and costs associated with the project are calculated at market prices.

The ONUDI method [14] introduces a number of modifications in this procedure. It takes consumption as the numeraire good in evaluating the project. In (4.1) B_t represents the increase in global consumption attributable to the project in year t. Similarly K_o must be expressed in equivalent current consumption units foregone by society.

Let us assume that each unit of investment or current consumption foregone yields a uniform rate of return equal to q dollars per year during N years, where q represents the marginal productivity of capital. Assume that these annual increments are subsequently consumed. Then the present value P, corresponding to an annual productivity q, evaluated at a social rate of discount i, would equal

$$(P/q)_t^i = \frac{(1+i)^t - 1}{i(1+i)^t} \tag{4.2}$$

If the useful life of the initial investment K_o is infinite then (4.2) can be shown to equal

$$(P/q)_t^i = \lim_{t \to \infty} \frac{(1+i)^t - 1}{i(1+i)^t} = \lim_{t \to \infty} \frac{1 - (1+i)^{-t}}{i} = 1/i \tag{4.3}$$

and hence

$$P = q/i \tag{4.4a}$$

The shadow price of investment (P^{inv}) represents the present value of future consumption generated by one unit of additional investment.

$$P^{inv} = q/i \tag{4.4b}$$

If the numerator is larger than the denominator then the opportunity cost of the investment $[(q/i) \cdot K_o]$ will be larger than its nominal cost K_o. Only under conditions of optimal economic growth will the marginal productivity of capital (q) equal the social rate of discount (i). Given this equation (4.1) can be rewritten as

$$B = \sum_{t=1}^{n} \frac{B_t}{(1+i)^t} + P^{inv} \cdot K_o \tag{4.5}$$

We then consider that not all of increased product stream q produced by the investment K_o is consumed, and hence a fraction s is reinvested. The shadow price P^{inv} is then given by the present value of the sum of the contributions to consumption (1-s)q and the contributions related to the reinvestments sq, where sq must be evaluated using the shadow price of investment P^{inv}.

When such investment is infinitely durable, then the shadow price of investment equals

$$P^{inv} = [(1-s)q + P^{inv} \cdot s \cdot q][\frac{(1+i)^t - 1}{i(1+i)^t}] \tag{4.6a}$$

and using (4.3) we obtain

$$P^{inv} = \frac{(1-s)q + P^{inv}sq}{i} = \frac{(1-s)q}{i-sq} \tag{4.6b}$$

Suppose now that the financial resources of the project to be financed partially out of current consumption. Equation (4.5) can then be rewritten as

$$B = \sum_{t=1}^{n} \frac{B_t}{(1+i)^t} - (a^{inv} \cdot P^{inv} + a^{con})\, K_o \tag{4.7a}$$

where a^{inv} represents the fraction of the initial investment cost subtracted from the total investment involved, and a^{con} the fraction subtracted from current consumption. Since the consumption good serves as numeraire a^{con} also represents total consumption foregone.

In equations (4.1), (4.5) and (4.7a) we assume that the benefits B_t are wholly consumed. If we now assume that only part of these annual benefits are consumed, $(a_t^{con} B_t)$ and part is reinvested, $(a_t^{inv} P^{inv} B_t)$, valued at the shadow price for investment then, equation (4.7a) becomes

$$B = \sum_{t=1}^{n} \frac{(a_t^{con} + a_t^{inv} \cdot P^{inv})B_t}{(1+i)^t} - (a_o^{inv} \cdot P^{inv} + a_o^{con}) K_o \tag{4.7b}$$

Finally if we assume that the annual benefits B_t are distributed between private investment, public investment, and consumption, and that the funds for investment also originate from these sectors, then equation (4.7b) can be rewritten as

$$B = \sum_{t=1}^{n} \frac{(a_t^{pri} P^{pri} + a_t^{gov} P^{gov} + a_t^{con})}{(1+i)^t} B_t$$

$$- (a_o^{pri} P^{pri} + a_o^{gov} P^{gov} + a_o^{con}) K_o \tag{4.8}$$

If we assume that the distributive shares of cost and benefits $(a^{pri}, a^{gov}, a^{con})$ stay constant over time, as well as the shadow prices for public and private investment (P^{pri}, P^{gov}), then above equations can be rewritten as the standard ONUDI evaluation formula

$$B = (a^{pri} P^{pri} + a^{gov} P^{gov} + a^{con})(\sum_{t=1}^{n} \frac{B_t}{(1+i)^t} - K_o) \tag{4.9}$$

where:

a^{pri} = fraction of benefits (costs) received (contributed) by private investment,

a^{gov} = fraction of benefits (costs) received (contributed) by public investment,

a^{con} = fraction of benefits (costs) received (contributed) by consumption,

p^{pri} = shadow price of private investment,

p^{gov} = shadow price of public investment,

B_t = benefits in year t (t=1, ..., n),

K_o = initial investment and,

i = the social rate of discount.

The differences between the shadow price of public and private investment depends on the differences in propensities to save and differences in the marginal productivity of capital in the public and private sector. Marglin holds that in practice it will be difficult to differentiate between these parameters for the private and public sector. In his examples he therefore assumes them to be the same for both sectors. Consequently there is also only one common shadow price for investment.

The proportion of benefits received and sources contributed will not be constant over time. If we assume that in the short run current public expenditure can not be decreased and that increased tax revenue can not be made available, then an expansion of a given investment project must imply a postponement of a project of lower priority. Private sector participation also may be initially negligible. If deficit financing cannot be used to shift the burden of financing onto consumption, then the initial contribution out of consumption (a_t^{con}) will also be small.

With respect to the distribution of benefits received there will be a long run tendency for the consumption share to increase, a_t^{con} should therefore increase over time. But this implies a lesser participation by private investment, a_t^{pri}. Given furthermore a constraint on public indebtedness and an upper limit to public versus private activity, it must follow that a_t^{gov} decreases over time. All this implies that the shadow price for investment must be continuously readjusted as well.

Little and Mirrlees [46] propose a method quite similar to that of Sen, Marglin and Dasgupta. Here however the capital good is chosen as the numeraire good. Equation (4.1) then represents the net benefits of a project in year t for an initial invested K_o.

Assuming that part of the net benefits are invested (yB_t) and part consumed $(1-y)B_t$, we have the problem of conversion of such consumption into equivalent investment. We assume as before that K units of investment yield $r_t K$ units per year. If we assume that all of this is reinvested we would have at the end of T years a cumulative reinvestment equal to

$$(1+r_1)(1+r_2) \dots (1+r_{t-1})\ K$$

If we consider that each unit of additional capital generates an additional consumption of $(c_t - m_t)\ N_t$ units, then the net benefits of these reinvestments in terms of consumption at the end of T year will equal

$$[(1+r_1)(1+r_2) \dots (1+r_t)(c_t - m_t)N_t] \tag{4.10}$$

where

c_t = consumption of the wage earner, year t,

m_t = marginal productivity of the wage earner, year t, and

N_t = additional employment of unskilled labor.

These net benefits in terms of additional consumption discounted to the present at the changing social rates of time preference i_t determines the present value of a unit of current investment relative to the extra consumption generated by employment.

That is to say, one dollar of investment is worth S_o dollars of present consumption or alternatively, consumption has a value of $1/S_o$ if these same resources had been invested. Consequently equation (4.10) can be expressed in terms of investment as

$$S_o = \frac{1}{1+i_1}(c_1-m_1)\,N_1 + \frac{(1+r_1)}{(1+i_1)(1+i_2)}(c_2-m_2)\,N_2 + \ldots \tag{4.11}$$

If we assume that the subscripted parameters in (4.11) remain constant, and if r is smaller than i, then the sum of the geometric progression in (4.11) can be written as follows

$$S_o = (c-m)N\left[\frac{1}{(1+i)} + \frac{(1+r)}{(1+i)^2} + \frac{(1+r)^2}{(1+i)^3} + \ldots\right]$$

$$S_o = (c-m)N\left[\frac{1}{(1+i)}\left(1 - \frac{1+r}{1+i}\right)^{-1}\right]$$

$$S_o = \frac{(c-m)N}{i-r} \tag{4.12}$$

Above result would be applicable to an economy growing at a constant rate of growth, with a constant rate of savings and structure of production.

In the above expression we assume that (c-m)N will be constant over time. But in the long run N=0, so that m will tend to equal c. If r is larger than i, then the economy reinvests at a rate above the social rate of discount (i), and the initial terms in (4.11) will increase successively with the expectation that at some point in time they will begin to decrease, i.e. when N begins to approach zero. Under these circumstances, it will be difficult to predict the value of S_o, because the reinvestments linked to the employment effect will generate additional consumption which can not be translated into the appropriate value for i.

Little and Mirrlees suggest that if the value of S_o calculated as in (4.12) appears to be excessive, then we should reestimate it considering that part of public revenue will be used for current consumption. In that case S_o is not only the value of investment relative to consumption but also an index of the social value of government revenue.

If we assume that part of public revenue is reinvested, i.e. $(1-G_t)$ at a rate of $r_t' = (1-G_t)\, r_t$ and that a part G_t is channelled towards current expenditure in a proportion $\overline{v}$, where $\overline{v}$ indicates the value of government expenditure relative to employment distributed consumption, then equation (4.12) becomes

$$S_o = \overline{v}_o\, G_o + (1-G_o) \left[\frac{1}{1+i} \left[(c_1-m_1)\, N_1 + \overline{v}_1\, G_1\, r_1\right] + \frac{1+r_1'}{(1+i_1)(1+i_2)} \left[(c_2-m_2)\, N_2 + \overline{v}_2\, G_2\, r_2\right] + \ldots \right] \tag{4.13}$$

where $\overline{v}_t\, G_t\, r_t$ is the additional benefit in terms of consumption. Given that $r_t' < r_t$ one expects that r_t' will be less than i_t, such that S_o decreases. Assuming that the subscripted parameters in (4.13) remain constant over time, we obtain

$$S_o = \overline{v}\, G + \frac{(1-G)(c-m)\, N + \overline{v}\, G\, r}{i - r}$$

or

$$S_o = \frac{(1-G)(c-m)\, N + \overline{v}\, G\, (i-Gr)}{i - r} \tag{4.14}$$

With reference to equation (4.1) B_t represented the net benefits in terms of investment attributable to the project in year t and K_o the initial investment. If we consider that part of these benefits are consumed in the form of wages, directly as related to the project or indirectly in a proportion (1-y) B_t, then its value in terms of investment will equal (1-y) B_t/S_t. The share of net benefits reinvested (yB_t) and the initial investment K_o are valued at the same rate because the investment good is used as the numeraire. The benefit-cost relation then becomes

$$B = \sum_{t=1}^{n} \frac{B_t\ (1-y)/S_t + yB_t}{(1+\lambda)^t} - K_o \tag{4.15}$$

where (1-y) and y are the marginal propensities to consume and to save respectively. The parameter λ represents the shadow interest rate.

When the project is financed and implemented by the private sector then social income generated will depend on the propensity to consume of the enterprise in question. Private sector consumption will equal $(1-y)(B_t - \gamma C)$ and private sector savings will equal $y(B_t - \gamma C)$ where C represents the cost of capital and γ the average rate of return expected for that type of investment.

When we compare the ONUDI and OCDE procedures we find the following similarities and differences. Both methods use net present value as an index of profitability. But the ONUDI method actualizes this in terms of consumption, whereas the OCDE procedure uses investment as a numeraire. The ONUDI method converts investment into consumption by means of a shadow price for investment. The OCDE method calculates consumption by means of the employment generated through investment. It uses for that purpose the shadow price of consumption.

There is one additional important difference. The OCDE approach utilizes border prices in the numeraire whereas the ONUDI method utilizes domestic market prices in the numeraire. Both methods recommend that the observed market prices be readjusted by means of appropriate shadow prices. But the procedures used for this do not lead to the same results, as demonstrated earlier.

Finally the ONUDI method weights the cost and benefit flows according to the distribution of inputs and outputs between the public and private sector, whereas the OCDE weighs such flows according to the source of financing between the private and public sector.

B. The Social Marginal Productivity of Capital

The social marginal productivity of capital method developed by Chenery [11] also aims to cover the deficiencies of partial investment criteria. An investment project exerts influence on various aspects of the economy, such as employment, production, balance of payments, etc. These effects are to some extent competitive. Furthermore, projects of different sectors will differ with respect to these economic aspects. The isolated selection of a project based on a partial analysis might therefore lead to a misallocation of resources. Chenery suggests a method of joint valuation in terms of additive social welfare of the separate economic effects of the investment project. Specifically Chenery values jointly, the capital turnover rate and the balance of payments effect of an investment project. He homogenizes these economic effects in terms of a common denominator. Assume the existence of a welfare function that reflects the distinct economic aspects related to the project.

$$U = U(Y, B, D, \ldots,) \tag{4.16}$$

where

U = social welfare index,

Y = effect on national income,

B = net effect on balance of payments and,

D = effect on distribution of incomes.

The effect of a project in the welfare index can be expressed as:

$$dU = \frac{\partial U}{\partial Y}\, dY + \frac{\partial U}{\partial B}\, dB + \frac{\partial U}{\partial D}\, dD + \ldots \tag{4.17}$$

Since U is measured in units of national income and dividing expression (4.17) by $\frac{\partial U}{\partial Y} = 1$ we have:

$$dU = dY + \frac{\partial Y}{\partial B}\, dB + \frac{\partial Y}{\partial D}\, dD + \ldots \tag{4.18}$$

Limiting the analysis to national income and balance of payments effects we rewrite (4.18) as

$$dU = SMP = dY + rdB \tag{4.19}$$

where dU is defined as the social marginal product of an investment (SMP) and r represents the marginal rate of substitution between national income and the balance of payments. Since, in underdeveloped countries there exist a substantial discrepancy between the social benefits (or costs) and private benefits (or costs) market prices must be adjusted so as to reflect their real social value. Chenery suggests that one exclude, in the valuation of inputs and outputs, the effects related to tariffs, taxes and subsidies. Similarly one should use corrected prices for those factors whose social opportunity cost is less than the market price, as is the case for economies with surplus labor.

There are also possible economies external to the project. Galenson and Leibenstein [28] suggest the inclusion of indirect costs associated with the project, specifically the additional social overhead required to maintain the labor force. Relation (4.19) can then be expressed as:

$$SMP = \underset{(a)}{\frac{V}{K}} - \underset{(b)}{\frac{C}{K}} + r \underset{(c)}{\frac{B}{K}} \tag{4.20}$$

Term (a) represents the coefficient of capital turnover, discounting the imported inputs. Term (b) shows the total cost of operation per unit of investment. That is, terms (a) and (b) represent the annual rate of profits per unit of investment. The third term (c) is the effect on the balance of payments per unit of investment.

Combining terms (a) and (b) we can express relation (4.20) in the following equivalent form:

$$SMP = \underset{(a)}{\frac{V}{K}} \; \underset{(d)}{\frac{V-C}{V}} + r \underset{(c)}{\frac{B}{K}} \tag{4.21}$$

According to this relation, the SMP is defined by the product of the percent margin of the social value over cost (term d), by the coefficient of the capital turnover and the balance of payments effect, where:

SMP = average annual increase in national income, plus its balance of payments equivalent,

K = project investment,

V = domestic social value added = $X + E - M_i$,

X = production increased caused by the project,

E = additional production due to external economies,

M_i = cost of imported materials,

C = total cost of the domestic factors = $L + M_d + 0$,

L = cost of labor,

M_d = cost of the domestic materials,

0 = overhead expenses including recovery of capital,

B = total effect on the balance of payments = $aB_1 + B_2$,

B_1 = effect on the balance of payments of the initial investment,

B_2 = effect on the balance of payments of project operation,

a = capital recovery factor and,

r = percentage difference between the shadow price (P_s) and the official price (P_o) of the rate of exchange $(P_s - P_0)/P_o$.

The variables mentioned above are conceived as annual flows, except K and B_1. The coefficient r, may be interpreted as the increase in national income equivalent to the improvement of the balance of payments in one unit, due to the effect of subvaluation or overvaluation of the rate of exchange. If the balance of payments were in equilibrium, r would be equal to zero. In this particular case the SMP would be determined by the capital turnover coefficient. In general, it is expected that in underdeveloped countries, the coefficient r will be larger than zero.

There exist different opinions on the importance and influence of the variables associated with the estimation of the SMP.

Buchanan [10] and Polack [59] argue that when projects of separate sectors are conjointly analyzed the degree of correlation between SMP and the capital turnover coefficient will be negative. They sustain that the exports and/or imports substitution is possible only in sectors with a low capital turnover rate. This is associated with a dependence on the external sector, and neutralizes the net effect on the balance of payments. Buchanan and Polac state that the most attractive investments are those projects with a high capital turnover coefficient. It in itself is an appropriate index for the selection of projects.

Kahn [43] sustains that the SMP is not correlated with the rate of turnover. He argues that the sectors and/or projects are characterized by their distinct structure of production and costs and that the effect on the balance of payments will depend on the structure of the respective sector and its degree of dependence on the external sector.

Chenery is of the same opinion as Kahn when the SMP method is applied to a portfolio of available projects. But he sustains that when a specific sector is evaluated, the capital turnover rate is preponderant in the determination of the SMP, because the discrepancy between costs and effects on the balance of payments of the projects is expected to be small. Additionally, Chenery sustains that the capital turnover coefficient serves as a guide in the selection of mutually exclusive projects.

The conclusions obtained in the application of the SMP method in Greece and Italy imply that a positive effect on the balance of payments is found for sectors with a high degree of national integration, especially the agricultural sector, because of a low coefficient of capital and a large value for the balance of payments effect. In the sectors characterized by low capital intensity operating costs are expected to be high. The advantage of projects intensive in labor is cancelled by a high cost of operation. In this manner a high marginal value is associated with a low capital turnover, which implies a negative correlation between V/K and C/K.

The SMP method does not weigh the incidence in the total profitability of the project the length of the gestation period. In the calculation of the SMP the initial investment K is taken as a global magnitude without considering the number of years required to complete the project. It thereby ignores the additional costs that the projects may suffer through delays.

A complete analysis with respect to this is performed by Marglin [47]. He analyzes the implications of performing a project in a fast or slow manner. We also analyze the incidence of the length of the construction period on the project profitability. Eckstein [16] sustains that when the SMP criterion is applied to projects of a same sector, the fluctuations in fixed costs do not influence the ranking of projects, because the ratio of fixed investment to operating cost varies little among projects to be compared. Eckstein states that the role performed by the interest rate in the SMP criterion is more restricted than in benefit-cost analysis. In the case of the application of the SMP method to projects of distinct sectors, the ranking is based on the interest rate stipulated by the planning authorities. A high interest rate will lead to the selection of projects of low capital intensity. With a lower rate of interest the SMP of all projects will increase because of the reduction in fixed costs. Capital intensive projects benefit most and this may cause a new ranking of the projects in favor of capital intensive projects.

C. The Semi Input-Output Method

One of the limitations of the partial models in the social evaluation of projects is the partial analysis of the project in relation to a specific objective, without considering its intersectoral effects, that is the multiplier and accelerating effects associated with the initial investment. The semi input-output method [38] aims to minimize the possible distortions of over or undervaluation of the economic effects, taking into account intersectoral effects of the project.

The principal characteristic of the semi input-output method is the distinction between national and international sectors [71]. This classification restricts the multiplier effect of autonomous investment as related to investment projects. By classifying the origin of production and services according to national and international sectors we can say that relative to the supply of international goods the internal market is not constrained by national production. There is therefore a separate degree of interdependency among these sectors. In the complete input-output model all sectors are related through the structure of interindustry deliveries. If there would be an autonomous change in the production of one of the sectors due e.g. to an investment project, then one expects induced changes in the production of all the other sectors. But this is not necessarily so with the semi input-output method, because the products of the international sectors are obtainable from abroad.

Consequently, there only exist a limited group of sectors that are interdependent, i.e. the sector where the change in production originates and the national sectors.

The merits of the investment project are then evaluated in relation to the change in the levels of production of the group of interrelated sectors. Benefit-cost analysis can then be applied to the group of interdependent sectors in order to obtain the total profitability of the project.

National sectors are defined as those sectors whose products or services can not pass national boundaries due to economic reasons, as e.g. due to transportation costs. Clear examples are the construction industry and other infrastructure related sectors. In like manner we can classify as national sectors, those sectors whose products or services are restricted to internal consumption, for cultural, social, legal, strategic and other reasons. Also we can identify as national sectors, those products or services which can not be exported or imported due to competitive disadvantages. Finally we include as national sectors those products or services that supply the internal market but leave no exportable surplus. The international sectors are defined as those sectors whose products or services can be freely imported or exported without the previously mentioned impediments.

Given this classification of national and international sectors, we can divide the input-output matrix in two rectangular sub-matrices that serve as base for the application of the semi input-output method. In the conventional input-output model, all sectors are related through a square matrix where the intersection of column i with row j represent inter-industrial deliveries. It is assumed that these purchases are proportional to the level of production X of each sector or algebraically:

$$A_{ij} = \frac{Z_{ij}}{X_i} \tag{4.22}$$

The A_{ij} coefficients constitute a square matrix showing the technological interdependency among the sectors of the economy. The fundamental ingredients in the input-output analysis are then these technical coefficients defined above as inputs per unit of product.

The common hypothesis in the input-output analysis is that the input-output relation remains constant at different levels of output. This relation is modified in the semi input-output method.

Suppose that an investment project is to be evaluated. The corresponding investment generates a determinate increase in final output. This additional production is due not only to capital as a factor of production but in combination with other inputs that ought to be produced by the other sectors. The increase in production in the other sectors leads to an increase in the utilization of services provided by the capital in those sectors, thereby requiring additional investment needed for the accomplishment of the original project. The additional investment requirements in the other sectors triggered by the project can be calculated through the analysis of the sectoral capital-output ratios. The fundamental assumption of the semi input-output method is that only the intermediate input produced by the national sectors must be provided by the internal production. Other intermediate inputs will be provided through imports. This avoids the improper usage of a scarce factor like capital and clears the way for increased employment generation.

Define X as the change in the vector of total production and variable Y as the change in the final demand vector. Suppose that the production originated by this investment project is entirely classified as final demand. Vector Y then represents the change in the production levels of the corresponding sectors originated by the investment project under consideration. The changes in the intermediate flows will be denominated as Z_{ij} where i defines the delivery sector (row) and j, the recipient sector (column). By definition the total change of the production will be equal to the sum of the changes of the intermediate deliveries plus the change in the final demand of each sector.

$$X = \sum_i \sum_j Z_{ij} + Y \tag{4.23}$$

The first term at the right represents the change in the intermediate demand which we define as Z. From the technological structure as represented by the first equation, we deduce a relation between the change in the intermediate demand and the change in the production, that is:

$$Z = A \cdot X \tag{4.24}$$

Substituting (4.24) in (4.23), the general result is:

$$X = A \cdot X + Y \tag{4.25}$$

Equation (4.25) gives us the relation between the change in production (X) and the change in final demand. Equation (4.25) is modified with the application of the semi input-output method. The original vector of the coefficients of imported inputs is now increased by the sum of the rows corresponding to the international part of the matrix A.

The national part of the matrix of input coefficients remains valid. This part consists in the rows of the matrix A; based on the intermediate deliveries by the national sectors, subdivided vertically in a rectangular sub-matrix where the recipient industries are the international sectors, identified as A_{nf} and a square sub-matrix where the recipient industries are the national sectors, identified as A_{nn}.

Equation (4.25) can be rewritten as

$$X_n = [A_{nf} \cdot A_{nn}] \begin{bmatrix} Y_f \\ \\ X_n \end{bmatrix} + Y_n \qquad (4.26)$$

and its solution can be written as

$$X_n = (1 - A_{nn})^{-1} \cdot [A_{nf} \cdot Y_f + Y_n] \qquad (4.27)$$

The solution of this system is given by the values X_n or the increase in annual gross production of the national sectors induced by the increase in the production of the sector where the investment is originated. When the investment project in the first instance does not generate a final demand in the national sectors, the vector Y_f will be zero and equation (4.27) can be written as:

$$X_n = (1 - A_{nn})^{-1} \cdot Y_n \qquad (4.28a)$$

When the project does not generate a final demand but the international sector does then we have

$$X_n = (1 - A_{nn})^{-1} \cdot (A_{nf} \cdot Y_f) \qquad (4.28b)$$

Relations (4.27) and (4.28) demonstrate that the change in the gross value of production will always be larger than the change in the gross value of the project under consideration. It allows us to calculate the direct and indirect effects of the investment project if the matrix to be inverted using the semi input-output is of smaller size than the original matrix. With the semi input-output method the matrix is of an order equal to the number of national industries.

The next step is to determine the total profitability of the project, taking into account the direct and indirect effects of the project in the originating and related sectors. We take as representative of the benefits the annual gross production by sectors and as a cost the autonomous and induced investment in the national sectors.

We assume that all investments are made in the same year and that production in every sector starts at the end of N years. The present value of the annual gross production of the corresponding sectors equals:

$$B_i = \sum_{t=1}^{b-1} \frac{\gamma X_{it}}{(1+r)^t} + \sum_{t=b}^{k} \frac{X_{it}}{(1+r)^t} \tag{4.29}$$

where:

B_i = present value of the accumulated gross production of sector i,

X_i = annual gross production of sector i, at full capacity,

γ = level of production as a percentage of full capacity,

b = year in which production in sector i reaches full capacity,

k = useful life of capital goods used in sector i, and,

r = social rate of discount.

Resolving for each sector we obtain the values for the B_i. To calculate total value added or total benefit of the investment project we correct the present value of the accumulated gross production of each sector by means of added coefficients such that

$$B = \sum_{i=1}^{n} Va_i \cdot B_i \tag{4.30}$$

where

B = total benefit,

B_i = present value sector i,

Va_i = coefficient of value added sector i, and

n = total number of national sectors.

The number of sectors will depend on the degree of disaggregation in the sectorization of the input-output matrix and on the classification of the national and international sectors.

The induced investments in the national sectors can be determined with the aid of the sectoral capital coefficients. Summation of these capital requirements yields the total of required capital.

$$C = \sum_{t=1}^{c} \frac{Ia_t}{(1+r)^t} + \sum_{i=1}^{n} \phi_i X_i \tag{4.31}$$

where

Ia_t = autonomous investment year t,

ϕ_i = capital-output coefficient sector i,

c = construction period, and

C = total investment.

The benefit/cost ratio according to the semi input-output method then equals

$$BC_{slo} = B/C \tag{4.32}$$

This result can be compared with the benefit/cost ratio which would result without considering the sectoral interrelation and indicates the degree of distortion.

One problem in the calculation of (4.32) is the absence of reliable sectoral capital-output ratios. We therefore take as a first approximation, the capital-output coefficients for machinery, equipment and new construction, weighting each coefficient by the estimated proportion of equipment and required construction of the induced investment.

The above method also yields the impact of the project on employment, the balance of payments and income. Total value added is distributed as salaries and wages, profits, interests and taxes.

In this manner the impact of the project on employment can be expressed through the following relation:

$$E = \sigma a \; Ia + \sum_{i=1}^{n} \sigma_i \, I_i + \sum_{i=1}^{n} Vs_i \cdot B_i \tag{4.33}$$

where:

σa = proportion of autonomous investment allocated for wages and salaries,

Ia = autonomous investment,

σ_i = proportion of induced investment allocated for wages and salaries sector i,

I_i = induced investment sector i,

Vs_i = coefficient of value added in wages and salaries sector i, and,

B_i = present value of the accumulated gross production, sector i.

If the shadow price for labor is known then the number of employment opportunities created would be:

$$\#E = \sigma a \; Ia/P_a + \left(\sum_{i=1}^{n} \sigma_i \; I_i + \sum_{i=1}^{n} Vs_i \cdot B_i \right)/P_i \qquad (4.34)$$

where:

P_a = shadow price of labor in the project originating sector, and

P_i = shadow price of labor in national sector i.

We assume uniformity in worker's qualifications. If otherwise we must specify the proportion of employees by stratum of specialization degree and by salaries and wages paid.

The redistributive income effect of the project can be estimated taking the coefficients of value added in relation to taxes so as to determine in a global manner the increase in tax revenue by sectors or regions. The disadvantage of this approach is that it does not discriminate between the contribution or proportion of taxes paid by each of the distinct economic agents.

The incidence of the project on the balance of payments must be determined via the net effect on the use and generation of foreign exchange. As source of foreign exchange we must determine which part of production contributes to an increase of exports as well as identify production that substitutes imports. We use the coefficient between exports and final demand to establish which part of the additional production generated by the national sectors is destined for exports. We then determine the import component of total investment and the direct and indirect import requirements of the national sectors. In this form the net effect on the balance of payments will be:

$$F_E = B_a^x + B_a^m + \sum_{i=1}^{n} Ed_i\, B_i - M_a\, I_a - \sum_{i=1}^{n} M_i\, B_i - M_a\, B_a \tag{4.35}$$

where:

B_a^x = present value of the exported gross production of the autonomous sector,

B_a^m = present value of the import substituted gross production of the autonomous sector,

Ed_i = coefficient that relates exports final demand of sector i,

B_i = present value of the gross production of sector i,

M_a = import coefficient of the autonomous sector,

M_i = import coefficient of sector i and,

B_a = present value of the gross production of the autonomous sector.

V. THE EVOLUTION OF THE PUBLIC INVESTMENT PROGRAM IN PERU, 1968-1975

With the purpose of obtaining a panoramic view of the Peruvian economy, we briefly describe the behavior of the principal global and sectoral indicators of the economy for the period 1968-1975.

First, we refer to the behavior and contributions to Gross Domestic Product. Subsequently, we analyze the program of public investment, considering its institutional origin, sectoral and regional distribution and financial resources. We include an analysis of the saving-investment relation by economic agents.

Later on we will refer to the priority package of public sector projects, their objectives and a brief description of the projects that have been selected for this study.

A. Economic Summary, 1968-1974

The Peruvian economy experienced during the period 1968-1974 an average rate of growth of 5.8 percent. From Table A.1 and A.2 it can be observed that the growth rate has been fairly constant in the last four years. The increase of the product per capita has been around 2.5 percent, which compares favorably with other Latin American countries. While the behavior of the economy, as measured by GDP can be said to be steady, there have nevertheless been important changes in its composition.

Gross Domestic Investment reflects the notable effort of increased capitalization. Gross fixed investment of the public sector has constantly been growing. Its participation in GDP increased from 3.8 percent in 1968 to 8.5 percent in 1974. Its average rate growth was 23.4 percent. In absolute terms the public investment in 1974 is fourfold that of 1968. This tendency will continue in the next few years, with the completion of the public projects in actual execution.

Public sector consumption with respect to GDP has been stable. Private sector consumption briefly increased its share. In percentage terms consumption for 1974 represents 88 percent of GDP which is a 3.5 percent increase with respect to 1968 (Table A.3). Exports were unstable, with both increases and decreases in absolute values. Its share with respect to GDP decreased from 20.6 percent in 1968 to 16.1 percent in 1974. As for the quantity of exports there were no significant changes, except in fish products, which in 1973 and 1974 decreased strongly because of a periodic oceanographic phenomenon. International prices for the different exports categories experienced to some extent compensating fluctuations. The diversified structure of exports stabilized exports earnings. Imports increased, especially in 1974 when its share relative to GDP is of 30.6 percent of 5.5 percent higher than of the preceding year. Both imports of investment and consumption goods increased, because the domestic supply was insufficient to cover demand. The expansion of public investment and the increase in international prices of capital goods also contributed to the increase in the total value of imports.

Table A.4 and A.5 give GDP by sector. One observes significant changes in its structure. The agricultural sector showed a small decline from 14.7 percent in 1968, to 13.0 percent in 1974. This sector had a growth rate of 2.4 percent and 2.3 percent in 1973 and 1974 respectively. The increase in production was less than the growth in population, and it was necessary to import food. This slow rate of growth is due partially to a price policy that depresses agricultural prices, discouraging investment and production in this sector. The government's effort was more over concentrated on irrigation projects, whose effects are of a long-run nature.

The fishing sector in the period 1968-1970 reached very high levels of production. Its participation was 2.8 percent of GDP in 1970; a year in which the anchovy catch surpassed 12 million metric tons. Due to abnormal climatological and biological conditions, the 1971 catch was only 4.4 million metric tons, and its participation in GDP declined to 1.1 percent.

The mining sector's share in GDP declined from 8.7 percent in 1968 to 7 percent in 1974. Production volume in this sector was stagnant, awaiting an intensive exploitation of mineral resources by means of public sector projects.

The industrial sector increased its participation from 23 percent in 1968 to 27 percent in 1974. The annual average growth rate equalled 8.7 percent; or triple that of the economy as a whole.

The construction sector increased its participation in GDP from 3.9 percent in 1968, to 5.2 percent in 1974.

B. The Public Investment Program, 1968-1975

The Peruvian economy since 1968 has pursued to establish a solid base for development through a large scale program of public investment. It consists of a package of projects aimed at the intensive and balanced exploitation of the country's resources. Prior to 1968 the public sector was circumscribed to infrastructure projects of low immediate productivity. The extraordinary capitalization effort by the public sector provides the economy with an important stimulus. Public GFI in 1975 was eight times the level of investment in 1968. The share of public investment in total GFI has increased constantly, from 29.5 percent in 1968 to 54 percent in 1975. This tendency will continue because the projects in execution are of long gestation. Private sector investment increased at only 4.8 percent, whereas public sector investment increased at a rate of 23.4 percent.

Table A.6 gives the distribution of public investment according to institutional origin. Investments of the central government by administration or contract, increased from 2,603 million soles in 1968 to 15,504 million soles in 1975. The investment of public enterprises goes from S/ 2,557 millions in 1968 to S/ 32,198 in 1975, or 74 percent of public investment for that year.

The Peruvian Petroleum Company (PETRO PERU) is in charge of the industrialization, marketing of petroleum and hydrocarbon products. Investment by this company reached S/ 14,705 millions in 1975. The principal projects are the Northern-Peruvian oil pipeline, enlargement of the La Pampilla Refinery, Exploration, Negro de Humo plant, Fertilizer plant, Catalytic plant and other projects.

The Mining Company of Peru (MINERO PERU) is in charge of three major projects, Cerro Verde I-II, Bayovar I and Ilo I-II Copper Refinery. The electricity company of Peru (ELECTRO PERU) is in charge of national electrification. Its most important projects are the Mantaro Hydroelectric Stage I and II and transmission lines.

In the industrial sector, the Steel Company of PERU (SIDER PERU) is doubling its capacity. The Peruvian Industries Company (INDU-PERU) has several projects in portfolio. The most important are: Diesel Motors, Machinery and Tools and Paper Plant.

In the transportation sector the National Telecommunications Company (ENTEL PERU) is developing an intensive plan of telephonic and telex extension of national scope.

Other public companies have undertaken smaller projects which contributed to the development of those sectors. A summary list of the most important public projects are presented in Table A.7.

The principal projects of the public sector are directly productive. Table A.8 shows that the sectorial structure of investment has changed dramatically. In 1968 38 percent of public investment was oriented towards basic infrastructure and 26 percent towards the productive sectors. In 1975 almost 70 percent of investment resources were channelled towards the productive sectors. The mining and petroleum sectors absorb 44 percent of this. The investments in the social sectors, increased gradually in absolute amount, but their participation in the total has decreased, as in the basic infrastructure sectors.

Table A.9 indicates the government's strategy for an equitable allocation of public investment, seeking to exploit at the same time regional comparative advantages. In the northern region of the country we find important irrigation projects (Chira-Piura, Tinajones, Olmos) and the majority of the industrial projects of INDU PERU. In the southern region we have Majes, Cerro Verde I and II and the Ilo Refinery. The investments in the eastern region are basically those of petroleum exploitation and the Northern-Peruvian oil pipeline. In the central region we have Mantaro I and II and several penetration highways. The investments in the Lima Metropolitan area, are oriented toward the improvement and maintenance of roads, social services and the La Pampilla Refinery. In general terms, the public investment has been distributed equally between regions, although recently, the eastern region has been the most favored.

Public investment was financed in part externally. For the period 1968-1975 external savings contributed 44 percent. The public treasury contributed with 40 percent and revenues generated by the respective public companies contributed 12 percent. Table A.10 shows the behavior of the different sources of financing for the period analyzed. One notes a negative correlation between internal and external sources. From 1968 on external resources undergo a gradual decrease, reaching a minimum in 1971, related to the difficulty of attracting external loans on acceptable terms. During this period the public treasury increased its support to the investment projects and programs, so as to avoid stagnation. The sector favored by external resources was the energy and mining sector due to the nature of its projects. In 1974 and 1975 these sectors absorbed 34 percent and 53 percent respectively of the total of the public investment. The agricultural sector is next in importance.

This remarkable increase in investment has not been accompanied by a parallel increase in national savings. As it can be seen from Table A.11 from 1970 on national savings has deteriorated in relation to the gross domestic investment. While national savings grew at an annual average rate of 10.7 percent, gross domestic investment grew at 22.4

percent. The savings/investment ratio was 1.16 in 1970 and only 0.39 in in 1975. In that year savings decreased in absolute terms. One reason for this low rate of savings is to the large difference between the interest rate and the inflation rate, which resulted in negative real returns. Nominal returns have been lower than the rate of change in consumer prices, which increased by 9.5 percent and 17 percent in 1973 and 1974 respectively.

Current government revenue increased at an annual average rate of 18.6 percent while current expenditure increased at 21.7 percent annually during the period 1969-1975. Savings on current account of the central government were not sufficient to cover capital expenditures, causing an increasing annual deficit. For 1975-1976, that deficit reached 67,000 million soles (Table A.12). One observes a strong increase in internal financing in the latter years. Part of the increase in current expenditure is due to subsidies interest payments on the public debt. Public companies also decreased their savings in current account, mainly because of the price stabilization policy adopted by the government. The negative effect of this price policy is reflected in Table A.13, where, in 1974 the public companies taken together, had a deficit of S/ 2,676 millions. Due to this financing public investment has depended increasingly on external savings which increased at 50 percent annually.

VI. ECONOMIC EVALUATION OF SELECTED PROJECTS

The most outstanding aspect of the Peruvian economy during the period 1968 through 1975 is without a doubt the extraordinary effort with respect to investment. Particularly in the field of public investment, which in the year 1975 was almost eightfold the level of public investment realized in 1968. This capitalization effort is the result of the increased scope of state activity in terms of the creation of new public enterprises and the increase of installed capacity of already existing state enterprises as related to the respective ministries. Because of this the participation of the public sector in gross investment has increased constantly. In 1975 it represented 54 percent of total gross investment equivalent to an increase of 25 percent over a period of seven years. One can expect that this tendency will continue, because the principal public investment projects are still in their construction stage, consequently numerous projects are still under construction.

On the other hand we must mention that while prior to the year 1968 the public projects were mostly channelled towards investment in infrastructure, since that year the emphasis has been put on projects that are directly productive. With reference to 1975 directly productive investments represent 70 percent of total public investment. This new orientation of public projects corresponds to the intention of the government to exploit in intensive and balanced form the potential resources of the country so as to generate the required resources for a balanced and sustained growth. Also one must emphasize that these public investments correspond to the intention of trying to exploit in an equilibrated fashion the comparative regional advantages of the country. In doing this one thereby avoids an excessive concentration of investments in a determined zone or region. In other words the public projects are located in rational form throughout the national territory of the country.

In general we can classify the public projects in three well-defined groups. First we have projects which are basically oriented towards the generation of foreign exchange, as in the case of mining and hydrocarbonic projects. Secondly we have projects that aim at increasing the domestic supply of goods and commodities, such as agricultural and industrial sector projects. Finally we also observe projects that support above directly productive projects.

With respect to the selected projects for their economic evaluation we would like to indicate the following. First such projects have been selected with the conviction that they are the most representative and that they reflect the strategy followed by the government. Given this we have selected twelve public projects respectively related to the agricultural, mining and industrial sectors.

In absolute amounts of investment these twelve projects constitute 70 percent of the total investment actually realized. Also the selected projects in each sector reflect the typical project and technology that predominate in their respective sectors. In other words these projects are prototypes of the investments realized in each sector in terms of technology and the nature of production. Also the projects in question are the most important within their respective sectors, having received first priority on behalf of the authorities in charge so as to assure the execution of these projects within the time horizon foreseen. We would like to point out that the oil pipeline project in northern Peru has not necessarily reflected this criterion even though it is one of the most important projects in the hydrocarbon sector. The reason for this is that the project is more closely identified with the transportation sector and not really with the directly productive sectors as usually defined.

In the following sections we will apply methods of evaluation from a social point of view whose methodological and conceptual basis have been considered in some detail in previous sections. The application or evaluations try to establish as to whether the public sector projects whose decisions for implementation were based on traditional investment criteria maintain their priority and social contribution when such projects are evaluated in terms of social-economic criteria.

First we will evaluate the projects separately and then we will make a comparison between projects and obtain the corresponding ranking of projects according to each criterion adopted. With this in mind we proceed initially to evaluate the selected projects using the methodology proposed by ONUDI [14]. In this alternative we proceed step by step to initially evaluate each project from the commercial point of view and then add the elements or concepts that convert this type of evaluation to that of a social benefit-cost analysis.

That is we first will take the flows of benefits and costs to compute the profitability of the project using market prices; this variant we will call Alternative I. Subsequently we proceed to make the necessary adjustments in the market prices so that they reflect their proper social opportunity cost. This variant constitutes our Alternative II. After this we will identify the role of the separate economic agents with respect to their contribution and participation in the costs and benefits associated with the project. In other words we will establish the distributional shares associated with each of those groups. This variant constitutes our Alternative II.

We have to indicate that for each alternative we will proceed by calculating the net present value, the benefit-cost ratio and the internal rate of return and making the necessary comparisons between projects. Subsequently we will proceed to apply the method proposed by Little and Mirrlees [46] maintaining the assumptions utilized with respect to the social rate of discount, the shadow wage for labor and the shadow price for foreign exchange. The fundamental change is with respect to the numeraire. With the method proposed by Little and Mirrlees we take investment as the numeraire good. For that purpose the salaries and wages for the period of construction as well as for the period of operation we will be converted in terms of investment utilizing the opportunity price of investment as already estimated in the model proposed by Marglin.

This variant of Little and Mirrlees constitutes our Alternative IV and will also be calculated in terms of net present value, benefit-cost ratio and internal rate of return.

We then apply the method formulated by Chenery [11], according to three possible variations. In the first alternative we proceed to calculate the social marginal productivity of capital, considering the total amount of investment as given and without considering the value of money over time. With respect to the production flows, the costs of operation and the effects on the balance of payments we will take the amounts which will correspond to the full utilization of the project. Also we do not consider the possible effects of discounting above revenue and expenditures streams. In alternative II of this method we will proceed to express the cost of the project in terms of its annual equivalent value. That is we will discount at the pertinent rate of discount the annual investment flows during the period of construction and then expressed in its annual equivalent value. With respect to the production flows, the national value added and costs of operation we will express these in terms of their annual equivalent. For that purpose we will calculate the present value of annual flows and subsequently we will express them in their annual equivalent. In Alternative III we will apply Chenery's method as in Alternative II, except that we will correct the market prices and utilize instead the previously calculated appropriate shadow prices.

Finally we will apply the semi input-output method [72], utilizing for that purpose the input-output matrix constructed for Peru for the year 1968 [36]. The initial matrix contains 34 sectors which we have reduced to 9 sectors as published by the Instituto Nacional de Planification [35]. This matrix of 9 sectors will be utilized in the application of the above mentioned criterion. Utilizing this method we will obtain the benefit-cost ratio considering both the direct and indirect effect of the initial investment.

Once we have applied the above mentioned evaluation methods we will make a comparison and ranking of the projects altogether. The purpose of this comparison is to determine and identify the degree of sensitivity of each project when we apply one or another evaluation method. Finally we apply a sensitivity analysis for alternative III as proposed by Marglin. This because an integral social evaluation method. In that analysis we try to establish the relationship between the social rate of discount, the opportunity price of investment and the shadow price of employment and the shadow price of foreign exchange and their effects on the selection and ranking of the projects.

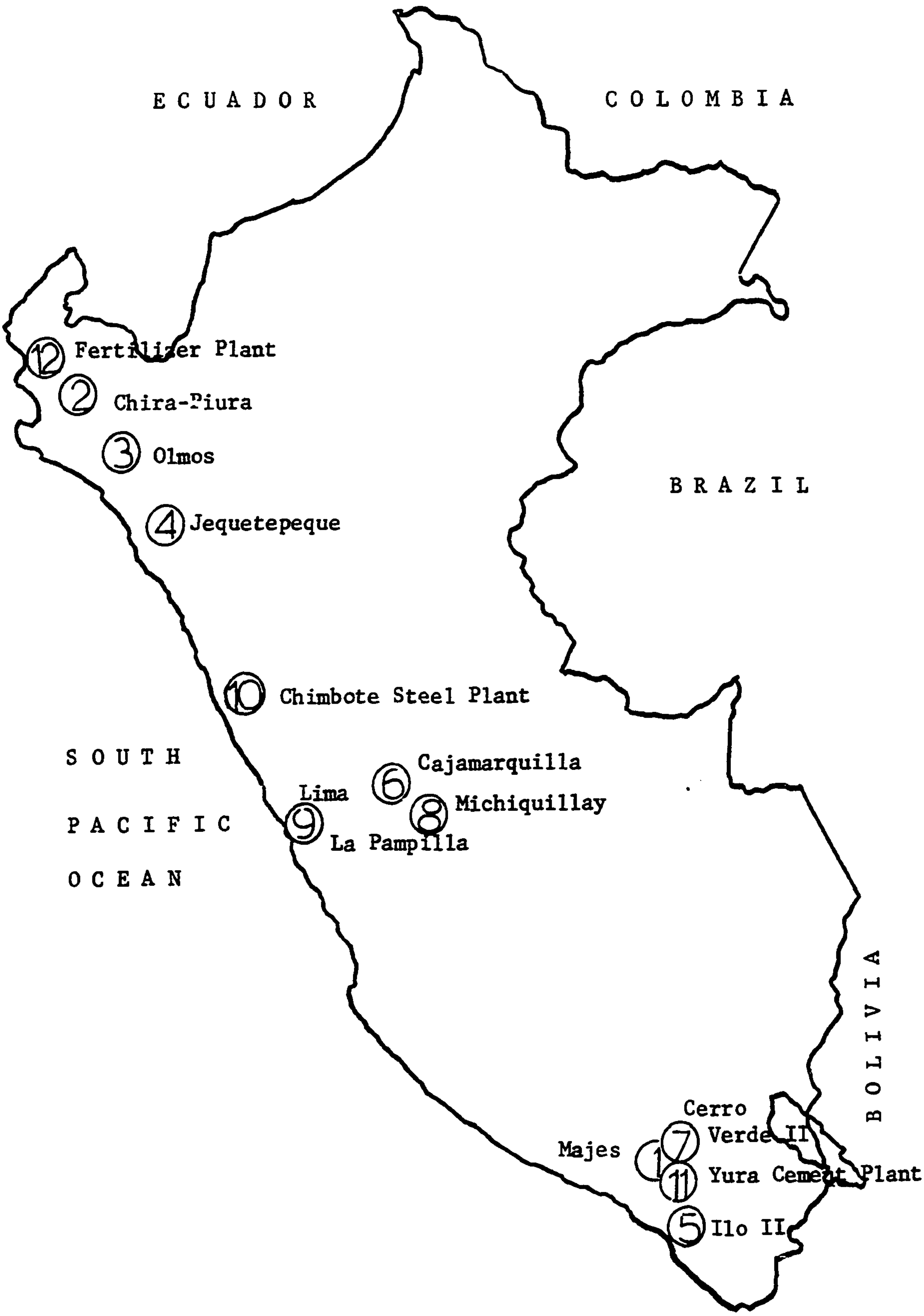
A. Description of the Selected Projects

MAJES The MAJES irrigation project [18] is located in the southern coast of Peru in the department of Arequipa (Figure 5). According to the feasibility studies this project will allow for the incorporation of 57,600 new hectares in the Majes Pampas (34,680 has) and Siguas (22,020 has) respectively. The total cost of the project at 1974 prices equals 10.9 billion soles or 154.3 million dollars, of which 6.1 billion soles correspond to agricultural development. The foreign exchange requirements are approximately 13.7 percent of the total cost of this project. The projection is to construct the engineering works within seven years, which are divided into two stages. In the first stage one hopes to construct the capture and derivation of the Siguas-Pampas of the Majes river, the main Majes canal and the system of distribution. The detail of the engineering works and their corresponding costs are listed in Tables B.11 and B.13.

We must observe that the construction of this project will allow for the generation of 500,000 kilowatts of electricity, utilizing for that purpose the waterfall between the terminal tunnel and the Bocatomas which derives the water from the Majes and Siguas areas. With respect to gross benefits one can see from Table B.12 that the gross annual production, at full production, is projected to reach 3.6 billion soles annually of which 2.0 billion soles corresponds to agricultural production and the remainder to livestock production. The project is expected to reach full production thirteen years after the conclusion of the civil engineering works. The total of cultivated hectares are estimated at 75,000, which implies an average utilization coefficient of land equal to 1.3. The project will benefit directly more than 10,000 families with an average farm size equal to six hectares.

<u>CHIRA-PIURA</u> The CHIRA-PIURA irrigation project [38, 39] is located in the northern coast of Peru in the department of Piura (Figure 5). According to the feasibility studies this project will improve the irrigation of the Chira Valley to the extent of 28,114 hectares and allow for the new irrigation of 7,471 hectares. In the lower and middle Piura valleys one hopes to improve the irrigation of 43,560 hectares and incorporate 1,040 new hectares. The total cost of the project in terms of 1967 prices equals 4.0 billion soles or 56.7 million dollars, the foreign exchange component equal to 47 percent. In Tables B.1 and B.4 one can see the total cost of the project according to the civil engineering works required. The derivation of CHIRA-PIURA, by means of Poechos Dam and the Imichira Canal is a vital importance for both

Figure 6.1. Map of Peru and the location of the twelve projects analyzed for the purpose of this study


ECUADOR
COLOMBIA
BRAZIL
BOLIVIA
SOUTH
PACIFIC
OCEAN
12 Fertilizer Plant
2 Chira-Piura
3 Olmos
4 Jequetepeque
10 Chimbote Steel Plant
6 Cajamarquilla
Lima
8 Michiquillay
9 La Pampilla
Cerro
7 Verde II
Majes
1
11 Yura Cement Plant
5 Ilo II

valleys, absorbing 29 percent of the investment. The direct investment attributable to the Chira Valley equals 1.7 billion soles. The direct investment attributable to the middle Piura Valley is only 51 million soles, specifically the construction of the Parales Canal. The remaining 1.0 billion soles are directly attributable to the lower Piura Valley. With respect to gross annual benefits, at full capacity, these are expected to reach 1.8 billion and 2.5 billion soles respectively for the Chira and Piura Valleys. The details as to production are listed in Tables B.2 and B.3. The project is expected to reach full production after sixteen years. The total number of hectares cultivated in both valleys are estimated to equal 127,371 hectares, implying an average utilization coefficient for land equal to 1.7 and 1.5 for the Chira and Piura Valleys respectively.

<u>OLMOS</u> The OLMOS irrigation project [41] is located in the northern coast of Peru, in the department of Lambayeque (Figure 5). According to the feasibility studies this project will allow the incorporation of 85,751 new hectares. The total concept of the OLMOS project also includes two electricity generation plans with a capacity equal to 520,000 kilowatts and additional investment in agricultural product processing plants. In this project the public sector cooperates with the private sector and within the private sector the contribution by the farmers are also of importance.

The contribution of the public sector equals 7.3 billion soles and the contribution of the private sector is estimated to equal 2.9 billion soles. The investments under the responsibility of the public sector refer to the irrigation works and the electricity generation plants. For the purposes of evaluation we excluded this later aspect. The total cost of the irrigation project in 1966 prices equals 6.3 billion soles, of which imported cost components represents 41 percent. With reference to Tables B.8 and B.10, we observe that the system of water distribution and the transandean tunnel absorbs 53 percent of construction costs. The associated agricultural development cost represents on the other hand, 41 percent. The period of construction of the project is estimated to equal twenty-six years. With respect to gross annual benefits, at full capacity, these are expected to reach 4.6 billion soles annually (Table B.9). It is expected that full production will be reached twenty-six years after the conclusion of the engineering works. The total of hectares cultivated are estimated to equal 94,951, which implies an average utilization coefficient of land equal to 1.1.

JEQUETEPEQUE The Jequetepeque irrigation project [61] is located in the northern coast of Peru in the department of La Libertad with areas extending into the department of Cajamarca (Figure 5). According to the feasibility studies this project will allow the incorporation of 10,400 new hectares and improve the irrigation of 49,600 hectares. The total cost of the project at 1972 prices will equal 33.2 billion soles or 46.2 million dollars. The foreign exchange cost of the project equals 46 percent of the total cost. This project is to be executed in two successive stages. In the first stage one will construct the Gallito Ciego Dam and the primary irrigation canals for a total of 2.0 billion soles. In the second stage the Cajamarca and Namora derivations will be constructed, representing 30 percent of the total investment. The agricultural development cost represents approximately 237.8 million soles. In Tables B.5 and B.7 we can see the decomposition of total investment. With respect to gross annual benefits, at full capacity, these are expected to reach 2.9 billion soles annually (Table B.6). It is expected that full production will be reached twenty-eight years after the initiation of the engineering works. The total of hectares cultivated are estimated to equal 105,782, which implies an average utilization coefficient of land equal to 1.7.

<u>ILO II</u> The Ilo Copper Refinery Project [20] is located in the southern coast of Peru in the department of Moquegua (Figure 5). According to the feasibility studies this project will allow an increase in the production of refined copper of 150,000 metric tons annually, from which 50 percent will be in the form of wire bars. Additionally it is expected to recuperate silver, selenium, tellurium and gold from the anodic mud. The total cost of the project at 1975 prices will equal 5.1 billion soles or 73.1 million dollars. The foreign exchange cost of the project equals 68 percent of the total cost. The components of the initial investment are found in Tables B.14 and B.15. The period of construction has been estimated in three years. The basic primary material for the Ilo Refinery is the blister copper provided by the Ilo foundry which processes the copper concentrated at the Cuajone and Toquepala mines. The gross benefits of this refinery are generated by the refining services implied in the blister operations which are provided by the Southern Peru Corporation. For purposes of this thesis we have estimated as the most

probable price for a ton of refined copper as equal to 225 dollars. The project will reach its full capacity of refinery production equal to 150,000 tons annually. After an initial period of three years it will be operated with a capacity of 127,000 metric tons. The revenue generated by this refinery service is entirely in terms of foreign exchange.

CAJAMARQUILLA The zinc refinery of Cajamarquilla [19] is located in the central region of Peru (Figure 5). The cost of the project in terms of 1976 prices equals 11.5 billion soles or 164 million dollars. The machinery and equipment cost represent 61 percent of total cost. The decomposition of the different components of this investment are represented in Table B.16. It is expected that the project can be concluded in five years. The project is conceived with the purpose of processing 199,000 tons of zinc concentrate annually, which actually are being processed abroad. In this manner one will increase the value added of zinc exports. The installed capacity of the refinery allows for the processing of 101,500 tons per year of refined zinc. With respect to the revenue of this operation it will be provided in 83 percent by the zinc refining services and as to the rest by the production of sulphuric acid, cadmium, copper cement, zinc and residual lead dust and silver dust. The details of the quantities and expected revenues are presented in Table B.17. It is expected that the project will enter in production in the last year of construction and then reach full capacity of production in the following year. The gross annual benefit generates foreign exchange equivalent to 3 billion soles annually or 43 million dollars if we can assume a base price of thirty-seven cents per pound of refined zinc.

CERRO VERDE II The copper project CERRO VERDE II [68] is located in the southern coast of Peru, in the department of Arequipa (Figure 5). This project is the continuation of the first stage of the Cerro Verde Project which has an annual capacity of 36,000 metric tons of copper. This second stage is by far the largest copper mining project in Peru. According to the studies it will have an annual production of 160,000 metric tons of copper. Moreover it is expected to produce molybdenum and sulphuric acid. The details as to production are presented in Table B.21. We have assumed that for the benefit-cost calculations we can work with a price of seventy-five cents per pound of copper. The total cost of the project in 1975 prices equals 81.6 billion soles or 1.6 billion dollars; where 52 percent will have to be financed in terms of foreign exchange. The decomposition of cost structure is represented in Table B.20. The period of construction is estimated to be four years and it is anticipated that full capacity of production will be reached ten years after initiating the engineering works. We should observe that whereas the first stage of Cerro Verde recovers copper on basis of a sulphuric acid process, but the second stage will use a process based on oxidation.

MICHIQUILLAY The Michiquillay Project [21] is located in the central zone of Peru (Figure 5). According to the feasibility studies it will allow an increase in copper production by 91,454 metric tons annually and it also will allow for the economical recuperation of gold and silver. In order to calculate gross benefits we have assumed as a base price seventy-five cents per pound of copper. The details as to production are represented in Table B.19. The total cost of the project in terms of 1975 prices equals 29.9 billion soles or 427.3 million dollars, where 43 percent will have to be financed in terms of foreign exchange. The decomposition of investment costs are represented in Table B.18. The period of construction is expected to equal six years. Full capacity of production is expected to be reached sixteen years after starting the engineering works.

LA PAMPILLA The enlargement of the La Pampilla Refinery [23] is located in the central coast of Peru in the department of Lima (Figure 5). The total cost of the project in terms of 1974 prices equals 3.9 billion soles or 57 million dollars. Machinery and equipment is the most important cost category absorbing 40 percent of total cost. The period of construction is estimated to equal four years. The details as to the decomposition of this investment are given in Table B.22. The gross annual benefits, at full capacity, are derived from the refining of 60,000 barrels of crude daily. The refining process will produce sub-products such as 84 octane gasoline, fuel for turbo engines, diesel fuel number 2, residual fuel number 6 and kerosene. The expected revenues from operation are detailed in Table B.23. It is expected that 69 percent of production will be used for the domestic market and the remainder will be exported. The project can enter into production in the fourth year of construction with 30 percent of installed capacity. In the subsequent year full capacity of production can be obtained.

The Chimbote Steel Plant   The enlargement of the Chimbote Steel Plant [24] is located in the northern coast of Peru in the department of Ancash (Figure 5). According to the feasibility studies the project has an annual production equal to 1.6 billion tons of steel products per year. The detail of quantities and value of production are presented in Table B.25. The total cost of the project at 1974 prices equals 47.8 billion soles or 684 million dollars, of which the foreign exchange cost represents 40 percent. The period of construction is fifteen years. The decomposition of costs are listed in Table B.24. The project begins to produce starting in the fifth year. It will reach full production sixteen years after the initial start of construction.

The Yura Cement Plant   The enlargement of the Yura Cement Plant [33] is located in the southern zone of Peru in the department of Arequipa (Figure 5). According to the feasibility studies this project will allow cement production to increase by 430,000 tons annually. The actual domestic capacity to produce is not sufficient to cover existing demand and Peru has had to import an increasing volume of cement in recent years. The total cost of the project at 1975 prices equals 1.1 billion soles or 15.5 million dollars, of which the foreign exchange cost represents 44 percent. The period of construction has been estimated at three years. Full production will be reached in the first year of operation. The details of the costs associated with this investment are listed in Tables B.28 and B.29.

The Fertilizer Plant   The Fertilizer Plant [22] is located in the northern coast of Peru in the department of Piura (Figure 5). According to the feasibility studies this project is designed to produce 168,000 tons of urea annually. For such purposes it is necessary to construct an ammonia plant with a capacity of 99,000 tons annually. This provides the basic raw material for the production of urea. Currently all urea is imported. The total cost of the project in terms of 1971 prices equals 1.9 billion soles or 26.7 million dollars. Of the total cost 55 percent will be in terms of foreign exchange. The period of construction is expected to be two years. Full capacity of production will be reached thirteen years after initiation of operations. The details as to investment costs are listed in Tables B.26 and B.27.

B. Review of the Feasibility Studies and Statistical Adjustments

1. General observations

The starting point for the presentation of the benefit and cost flows of the selected projects are based on the respective feasibility studies. In principle we accept these studies with respect to their engineering aspects, the proposed processes of production and the technological alternative selected as being the most economical for each type of project. The revision of the technical aspects and eventual modifications therein can not be considered for the purposes of this study, because it would require comprehensive technological knowledge which can be provided only by a team of qualified professionals in each of the fields related to the projects mentioned above.

With respect to the preparation of these feasibility studies one observes that there has been a substantial change in the preparation of these. Prior to 1968 it was generally necessary to contract foreign consultants or firms for the preparation of these. It put into relief the technical limitations of national consulting offices. But after 1968 the respective ministries or public enterprises that prepare feasibility studies are also the entities charged with implementation of these feasibility studies. One observes that in the discussion as to costs and financial resources that such figures are based upon these up-to-date studies. It has also impressed upon the planning authorities that due to the scarcity of domestic currency and foreign exchange these projects in all their associated aspects must be carefully studied.

Nevertheless we must indicate that for several reasons the feasibility studies tend to overestimate the profitability of projects. With respect to overestimation of benefits these are related to the tendency to always present the projects with at least a minimum degree of profitability. This is reinforced because the concerning authorities know that the priority of the projects is dependent to a large extent on the degree of its profitability. On the other hand we must be aware of the limitations with respect to reliable budgetary and cost estimates of these projects. Generally the authorities concern will tend to underestimate the cost if only to be able to be accommodated within the projected budget for the coming year. Hirschman [32] has treated the above aspects in detail.

Given this tendency of overevaluation of benefits and underestimation of costs, we proceeded to review and to revise these feasibility studies to verify the consistency of the costs, quantities and prices of final products.

With respect to total construction costs we proceeded by verifying as to whether the engineering works, equipment and associated costs referred to in the feasibility studies are consistent with that stipulated in the calendar of operation. With this in mind we visited the implementing agencies at their location in the respective geographic areas of Peru, because there always was the possibility that some important engineering aspect or piece of equipment had been excluded. In this respect we cite the Majes irrigation project where one included a number of engineering works related to housing and roads which should have been excluded. Also the machinery and equipment for the construction phase were purchased by the ministry of agriculture rather than considering the cheaper alternative of renting such equipment. This alternative was not considered in the feasibility study but we have included the alternative for purposes of evaluation.

After verification of the investment aspects of the projects we proceeded to express the amount of money involved in terms of 1976 prices. We refer to this as adjusted costs in the respective tables. This adjustment is necessary because for a comparison between different projects we needed a common annual base of comparison.

When we refer to prices according to feasibility studies this always refers to the year in which these studies took place. Previously we already mentioned the dates of these studies. For the purposes of establishing a common base year we have used the deflators listed in Table 6.1 provided by official statistical sources. At the bottom of each deflator we have indicated the respective source. With respect to construction costs we have tried to identify the most important categories using the appropriate deflator. Similar operations took place for machinery, equipment, construction, material and labor. In this we have identified that part which can be paid for entirely by domestic currency and that part which will require foreign exchange. In the tables by projects we show these figures and the deflators utilized and the corresponding figures in terms of 1976 adjusted cost.

For some projects we have used the information as stipulated in the budgets associated with the feasibility studies. The reason for this is that the figures stipulated in feasibility studies differ very much from the figures associated once the project started. In this case one cannot justify the use of actualized figures based on deflators because there exist an unexplainable gap, not because of the increase in the costs but rather because of a substantial underevaluation of the original cost. For the projects for which we make this type of adjustment we will make the respective references. With respect to the costs of operation we have proceeded with the same methodology. That is, after verifying the specified costs in the studies we then proceeded to express the figures in terms of 1976 prices. The corresponding tables are presented jointly according to detail by studies and items and according to deflators used. On the side of benefits we proceeded to verify the productive capacity of each project. After verification of the physical volume of production we proceeded to value this production in terms of 1976 prices. We must observe that in the case of irrigation projects we first verified whether the yields stipulated in the studies differ substantially from the average

Table 6.1. Price indexes of investment goods, labor and principal inputs, 1966-1976 (percentages)

Year	Capital Goods Imported[d]	Capital Goods National[e]	Construction Materials Imported[d]	Construction Materials National[e]	Labor All Groups[c]
1966	50.7	46.9	49.3	50.5	26.6
1967	51.2	47.4	50.0	51.5	30.0
1968	51.8	47.8	50.5	52.8	33.7
1969	52.6	48.3	59.7	54.7	36.3
1970	53.7	49.0	51.2	55.4	38.5
1971	55.1	49.5	53.8	56.1	41.4
1972	60.9	50.2	58.1	58.1	46.2
1973	70.1	60.0	68.3	60.4	52.0
1974	80.1	68.4	82.2	66.7	59.2
1975	93.9	80.0	93.9	76.4	71.0
1976	100.0	100.0	100.0	100.0	100.0

[a]Source [55].
[b]Source [4].
[c]Source [38].
[d]Source [34].
[e]Source [5].
[f]Source [25].

Electricity[a]	Petroleum and Subproducts[b]	Copper[b]	Steel Products[f]	Cement[c]	Urea[b]	Services[c]
37.9	11.1	36.1	n.a.	n.a.	n.a.	n.a.
37.9	11.1	40.1	n.a.	n.a.	n.a.	n.a.
44.2	14.8	55.7	n.a.	45.1	58.8	n.a.
44.7	14.8	63.7	n.a.	51.2	50.3	n.a.
44.7	14.8	61.6	n.a.	52.0	43.3	n.a.
44.7	20.8	43.3	n.a.	52.0	41.3	44.8
44.7	20.8	42.6	46.5	52.4	53.2	58.1
49.5	25.0	73.6	50.3	52.4	85.1	65.4
49.5	25.0	92.0	62.0	52.4	160.2	74.1
65.8	70.4	50.4	77.7	60.6	177.6	83.3
100.0	100.0	100.0	100.0	100.0	100.0	100.0

yields of the agricultural areas surrounding that project. After sometimes necessary adjustments we then proceeded to express the value of production in terms of 1976 prices.

On the other hand we must state that the review of feasibility studies all comply in general with the principal features and economic aspects of the projects. In other words such studies do contain the fundamental elements necessary for the circumstances leading to determining as to whether the investment is worthwhile. Nevertheless there obviously exist some heterogeneity as between projects. For example construction costs in some cases are summarized in a few lines items whereas in other studies they are available in greater detail.

We also observed that there did not exist complete homogeneity with respect to the usual conventions used in executing and evaluating the economic feasibility of the projects selected for this study. In some instances the benefits and costs are expressed in terms of present values, annual equivalent and even future equivalent values. Also when referring to the discounting process there are differences as to the choice of the base year. In some instances the year zero is defined as the first year of construction and in other instances year zero is synonymous with the year in which production starts. This does not necessarily change the profitability of the projects but it does make it impossible to compare one project with another project.

For the purposes of our economic evaluation we have tried to standardize the format of the flows of benefits and costs and also we standardized the methodologies used in evaluating the respective projects involved. With respect to the evaluation methodologies used, virtually all feasibility studies were based on a commercial profitability criterion with predominance of standard benefit-cost analysis and the internal rate of return. Also, we have observed that in the application of the benefit-cost ratio some studies used the conventional method and other studies do introduce certain modifications. For example the costs of operation are sometimes added in the denominator which is the conventional method, and for other projects are subtracted from the numerator which is a modification of the traditional procedure.

With respect to the rate of discount used this varies between projects from 6 percent in the case of the Olmos irrigation project and 20 percent for the Jequetepeque irrigation project. Similarly there exist discrepancies with respect to specification of the benefits. In some instances these refer to net income, value added, sales, gross value of production, etc.

For the purposes of our evaluation we have standardized the figures of benefits by taking the gross value of production attributable to the project in their respective years. On the basis of this we then proceeded to apply the several evaluation criteria explained before. We must indicate that in the process of standardization we are considering the corresponding investment categories relevant for an economic evaluation. That is, certain financial outlays must be excluded from an economic evaluation even though they are part of a financial evaluation. For such purposes we have followed the procedures suggested by ONUDI [14] and Gittinger [29].

First we have to consider the treatment of taxes within a context of an economic evaluation. In a financial evaluation the taxes are considered as a cost to the enterprise, because they effectively constitute expenses for that firm paid to the government and they logically diminish the net revenue associated with the project. In the case of an economic evaluation taxes are not considered as a cost but rather as a transfer of income of the project to the government. The government for its part is responsible to make the proper use of such funds as the representative of society. In other words in the economic evaluation taxes are part of benefits and should not be subtracted as a cost attributable to the project.

In the case of subsidies these constitute a transfer payment of society to the project, and this implies a cost imputable to the project. For an economic evaluation the market prices must sometimes be adjusted so as to reflect the amount of the subsidy. In a financial evaluation no such adjustment is required because the firm operates according to the prices which prevail in the market.

In relation to interest payments we have that in a financial evaluation these costs must necessarily be met. They therefore must be deducted from gross revenue before we can establish net revenue. In the case of an economic evaluation such interest payments are not considered as a cost attributable to the project. It is precisely in the computation of the profitability of the project that one looks for the rate of return on capital that society has decided to allocate for the project. As in the case of taxes, interest payments are not considered as a cost but rather a transfer payment. In the case of the projects considered here we do not consider interest payments during the period of construction because these payments are capitalized and subsequently are part of the principal.

In the case of foreign loans the interest payments constitute a cost imputed to society as a whole. This is because there does not exist an additional cost to society because we assume that the economy requires a continuous flow of foreign savings and that in the absence of the project such funds would be utilized for other purposes or projects. However what has to be taken into account is that the costs of construction imputed to the project when the expenditures are being met during the construction stage and not when one repays the principal during the period of amortization. This because such funds represent a cost for society from the moment that one begins to construct the project.

On the other hand, depreciation constitutes an accounting figure rather than a cost as such. When we apply a financial evaluation, depreciation influences the calculation of taxes. In the case of an economic evaluation this is excluded.

Finally the financial evaluation is based on market prices whereas with an economic evaluation for some projects is maybe necessary to adjust some of these so that they reflect the true social opportunity cost.

2. <u>Adjustments in agricultural projects</u>

Beginning with the Majes project it was necessary to recur to additional sources of information in order to determine with greater precision the expected costs and benefits. For those purposes we have utilized the report of the ORDESUR Committee [13], presented during the negotiation of the project. We have also used the periodic reports prepared by the Executive Committee of the Majes Project [15].

According to feasibility studies the engineering costs had been estimated in 3.7 billion soles which we did take initially as a base for our evaluation. But that figure would differ significantly from the initially prepared budget as to construction costs. This difference is not entirely attributable to an underestimation or increment in costs. When we reviewed the additional information we found that the feasibility studies had not included certain necessary investments. Principally those referring to infrastructure and the acquisition of construction equipment. It is to be observed that the acquisition of such equipment is the direct result of the nature of the negotiations pursued.

In Table B.11 we present the decomposition of costs in terms of machinery, materials and labor both in national currency and the foreign exchange components. In the same table we present jointly the costs in terms of 1974 prices and in terms of 1976 adjusted costs.

On the other hand the value of production has been adjusted according to the average yield of the zone within which the project is located. For those purposes we utilized the information provided by the Agricultural Development Bank [3]. Specifically the basic budgets by crops as prepared by the bank agencies located in Ocona, Arequipa and Camana. These budgets present in detail and for one year to the next the yields and costs per hectare for different types of crops. It must be observed that the Agricultural Development Bank uses this information prepared by its own technicians as a basis for extending agricultural credit to the farmers in the zone in question. For purposes of our research we considered something like 200 reports, all referring to the above mentioned agencies located within the zone of the project. With this information we then proceeded to verify as to whether the yields estimated in the studies are consistent with the yields traditionally reported for that zone. After verification and adjustment of such yields we then proceeded to calculate the gross value of production by crop in terms of 1976 prices.

On the side of operation costs we proceeded in a similar manner again utilizing the information of the Agricultural Development Bank with respect to labor cost, fertilizer, machinery and other inputs. This allows us to compare the costs per hectare referred to in the studies and those obtained according to the reports prepared by the bank. In Table B.12 we present the costs and yields per hectare for each type of crop according to the studies [13] and at 1976 adjusted prices.

With respect to the Jequetepeque project it was not necessary to refer to additional sources of information. In other words we used without substantial modification the figures prepared by the feasibility studies [61]. In Table B.5 we present the costs of the project at 1972 prices decomposed by major components such as machinery, labor, materials and also in terms of national currency and the foreign exchange costs. In the same table we present the adjusted costs indicating the respective deflators. We have not considered interest costs during the period of construction.

On the other hand the value of production has been adjusted according to the average yields of the zone of the project. Similarly we have utilized the reports of the loan division of the Agricultural Development Bank as prepared for the agencies located in Pacasmayo, Cajabamba, Chilete, Cajamarca and Huamachuco. These reports gave us the relevant information about yields and costs of production per hectare for the zone in question. According to this information we adjusted the yields and costs stipulated in the studies. In total we used a sample of 150 crop reports. Once we had made the necessary adjustments for each crop we then proceeded to express the value of production in terms of 1976 adjusted prices. In Table B.6 we present jointly the yields and costs per hectare according to the initial studies, after having made the necessary adjustments. We must indicate that we have only considered the Jequetepeque irrigation project and not the hydroelectric power plant of Gallito Ciego and San Juna. In the feasibility studies both hydroelectric stations are mentioned but they are not considered in the financial evaluation.

With respect to the Olmos project the information utilized comes from the feasibility studies [41]. For purposes of our evaluation we are only considering the irrigation project which is financed entirely by the public sector. In Table B.8 we can see the costs of the project according to the original feasibility study and in terms of adjusted prices. Again we did not include interest payments during the period of construction. The yields and costs per hectare of the original feasibility study were adjusted according to the reports of the Agricultural Development

Bank, specifically those prepared for the agency in Jayanca which covers the totality of the area of the project. After having made such adjustments we proceeded to express the value of production in terms of 1976 adjusted prices. The details of costs and revenues per hectare and by crops are presented in Table B.9.

With respect to the Chira-Piura project the statistical source of information again comes from the feasibility studies but according to the different versions prepared by the same consulting firm. This because the project was initially presented as the integral development of the river basins of Chira, Piura and Tumbes. Subsequently such projects were evaluated in greater detail separately. For our purposes we are considering only the Valleys of Chira, Middle and Lower Piura, since they have the major infrastructure works in common.

With respect to the construction costs we based our information on that provided by the integral feasibility study [39]. In Table B.1 we present jointly the costs according to the original feasibility study and in terms of 1976 adjusted prices. Again we do not include interest payments during the construction phase. With respect to yields and costs per hectare these have been evaluated separately for each valley and subsequently we have aggregated these estimates so as to obtain the corresponding estimates for the whole of the project. With respect to the necessary adjustments in volumes and costs of production for the Chira Valley we have utilized the feasibility study of the Chira Valley [40]. In Table B.3 we present the yields and costs per hectare for the Chira Valley in terms of 1976 adjusted prices. This adjustment has taken into account the reports of the Agricultural Development Bank for the agencies located in Piura and Catacaos. The sample used for this purpose was 100 reports.

On the other hand in order to make the adjustments in revenues and costs per hectare for the middle and lower Piura Valleys we have used the feasibility study of the Piura Valley [38]. The respective adjustments were made utilizing the information of the Agricultural Development Bank with respect to the agencies located in the Piura Valley. The details of revenues and costs according to the original study and in terms of 1976 adjusted prices are presented in Table B.2. One should be aware of the fact that the Chira-Piura project is an integral project, because both valleys are dependent 100 percent on the Poechos Reservoir and the Imichira Canal. One can not therefore meaningfully evaluate each valley separately.

Finally, we must indicate that we have not changed for all of the irrigation projects mentioned the estimated hectares to be irrigated or improved or their estimated cropping intensity.

3. Adjustments in the mining projects

The basic information for the Cerro Verde II project has been taken from the corresponding feasibility study [68]. In Table B.20 we present the costs of the project in terms of 1975 feasibility study prices and according to 1976 adjusted prices. For each cost component we also report the corresponding deflator used. From this table one can also obtain the decomposition of costs associated with the project according to equipment, machinery and labor and again specifying the national and foreign exchange components. As for the other projects we have not included the interest payments to be paid during the construction period of the project. Also the construction costs are imputed to the project at the moment that the engineering works are executed and not when one amortizes the corresponding loans. That is we ignore in this instance the period of grace which is associated with the loan which will finance this project. In the feasibility study the costs of the project are imputed according to the amortization of the principal. In Table B.20 we present jointly the costs of operation according to the feasibility study and according to 1976 adjusted prices. Such costs of operation do not include taxes or interest payments. With respect to the value of production we have not made any adjustments. We therefore accepted the quantities and prices foreseen in the feasibility study.

With respect to the enlargement of the Ilo refinery we have accepted the feasibility studies [20] which were completed taking 1974 as a base year. In Table B.14 we can appreciate the decomposition of the costs of the project according to the original study and according to 1976 adjusted costs. Again we do not include interest payments during the period of construction. With respect to production we have accepted as given the quantities specified in the studies. Nevertheless we must indicate that the revenue generated by this operation are related to the further refining of copper provided to the Ilo refinery by the Southern Peru Corporation and not by the direct sale of copper.

The price for refining the blister copper agreed between Minero Peru and the Southern Peru Corporation is equal to $194 per metric ton plus an additional cost related to labor and energy equal to \$10.47 per shift and 2.2 cents per kilowatt-hour respectively. With an additional adjustment clause to reflect variations in the cost of labor and energy the basic refining cost of \$194.00 per metric ton increases by 0.6 percent and 0.15 percent respectively. The value of annual production has been estimated considering a refining service charge equal to \$225.00 per metric ton. This price allows for an increase of one dollar per shift and for four cents per kilowatt-hour utilized.

With respect to the Cajamarquilla Zinc Refinery [19] we dispose of the 1976 feasibility study. For this reason it was not necessary to adjust the proposed investment costs and operation costs. In Table B.16 we present the details of this project. With respect to the revenue we have verified the quantities foreseen with respect to production as well as for the refining of zinc and corresponding subproducts. The revenue to be obtained for refined zinc are based on thirty-seven cents per pound for the so-called prime western quality. Again the income postulated is related to the service provided by refining the zinc and because of the sale of the product as such. The operational costs are listed in Table B.16. We have not included interest payments and taxes.

With respect to the Michiquillay mining project the information for the study again was based on the corresponding feasibility studies [21]. In Table B.18 we listed the costs of the project in terms of 1975 and 1976 adjusted prices. Again we excluded interest during the period of construction. Also the cost of the project is calculated according to the actual calendar of disbursements and not according to the calendar of amortization of principal. In the costs of operation we have excluded the corresponding items related to taxes, depreciation and interest payments. In Table B.18 we listed the details of the costs of operation according to the feasibility study prices and according to 1976 adjusted prices. With respect to the anticipated production we have not made any adjustment and have therefore accepted the figures as presented by the feasibility studies.

4. Adjustments in the industrial projects

The basic information for the evaluation of the enlargement of the La Pampilla petroleum refinery was obtained entirely from the corresponding feasibility studies [23]. In Table B.22 we present the details of the costs of the project both in 1974 and 1976 adjusted prices. With respect to the costs of operation we excluded depreciation and taxes. In the same table we present the costs of operation in terms of 1974 and 1976 adjusted prices. With respect to revenue calculations we indicate first of all that the quantities of production foreseen and the value of this production have been taken from the feasibility studies. The gross value of production was estimated according to the price of gasoline and subproducts then existing. The sale price was calculated considering a price of $2.50 per barrel when the international price was already more than $11.00 per barrel. For the purposes of evaluation we considered the prices of these products as they existed in 1976.

With respect to the enlargement of the Chimbote Steel Plant the basic information was provided by the corresponding feasibility studies [24]. In Table B.24 we present the costs of the project in terms of 1974 and

1976 adjusted prices. No adjustment was necessary in terms of the costs listed. The adjustment of prices has been based on the prices provided by the steel plant as foreseen for 1976. It must be observed that in the feasibility studies the financial evaluation takes the steel plant as a whole; that is, actual productive capacity plus the enlargement of this. One does not specify which part of the value of production is imputable to the project.

With respect to the Yura cement project again the feasibility studies provided the basic necessary information [33]. In Table B.28 we present both the cost of the project and the operational costs according to the feasibility study prices and according to 1976 adjusted prices. We also indicate the costs in terms of domestic and foreign currency respectively. These flows do not include taxes, depreciation and interest payments. The figure of revenues are based upon the assumption of a 20 percent increase in the price of cement.

The feasibility studies related to the Fertilizer Plant [22] consider two production alternatives. The first one is based on an annual production equal to 188,000 metric tons of ammonia and 168,000 metric tons of urea annually. The second alternative which was actually adopted, considers an annual production of 99,000 metric tons of ammonia, without a reduction in the previously stated production of urea. The difference is due to the fact that with the second alternative all of the ammonia produced is used for the production of urea. In Table B.26 we present the construction costs for the alternative selected at both 1971 and 1976 adjusted. Operation costs again exclude taxes and interest payments.

Finally, we must observe that in making these adjustments for each project we have never considered as costs taxes, interest payments or amortization during the period of construction. For all projects the foreign exchange adopted was that which existed at the end of 1976, that is S/. 70.0 = $U.S. 1.00.

C. Social Evaluation of the Selected Projects

1. Marglin approach

Initially we will proceed to apply the method proposed by ONUDI [14] in successive steps in order to appreciate the influence on the profitability of the projects of the different assumptions and adjustments that convert a financial evaluation into an economic or social evaluation. In other words we will start applying the traditional analysis, which we refer to as Alternative I, and then we proceed to realize the necessary adjustments in the market prices, which constitute our Alternative II. Subsequently we proceed to identify the participation in costs and benefits of the different economic groups associated with the project. Once this has been done we will estimate the profitability indexes in terms of the consumption generated, according to the marginal propensities to save and invest of each economic group associated with the project. This constitutes our Alternative III.

It must be observed that in each alternative we will estimate for each project the net present value, the benefit-cost ratios and the internal rate of return. In each case we will compare the outcomes for each alternative verifying if the application of one or another profitability index produced a different ranking of projects. In this way we proceed to estimate the profitability indexes without making any adjustments in the market prices. From now on we will refer to this alternative as Alternative I. The estimation of the respective profitability indexes are based on the following relations:

$$NPV = \sum_{t=1}^{n} \frac{(B_t - C_t)}{(1 + i)^t} - \sum_{t-1}^{n} \frac{K_t}{(1 + i)^t} \qquad t = 1, \ldots, n \tag{6.1}$$

$$B/C = \sum_{t=1}^{n} \frac{(B_t - C_t)}{(1 + i)^t} \Bigg/ \sum_{t=1}^{n} \frac{K_t}{(1 + i)^t} \tag{6.2}$$

$$\sum_{t=1}^{n} \frac{(B_t - C_t)}{(1 + r)^t} - \sum_{t=1}^{n} \frac{K_t}{(1 + r)^t} = 0 \tag{6.3}$$

$$B_t = B_t^n + B_t^f + V_t \tag{6.4}$$

$$C_t^n = C_t^n + C_t^f \tag{6.5}$$

$$C = C_t^I + C_t^W + C_t^O \tag{6.6}$$

$$K_t = K_t^n + K_t^f \tag{6.7}$$

$$K_t^n = K_t^m + K_t^I + K_t^W + K_t^a \tag{6.8}$$

where:

NPV = net present value at market prices,

B/C = benefit/cost ratio at market prices,

r = internal rate of return,

i = social rate of discount,

B_t = annual gross production, year t,

B_t^n = annual gross production in domestic currency, year t,

B_t^f = annual gross production in foreign currency, year t,

V_t = salvage value, year t,

C_t = annual operating costs at market prices, year t,

C_t^n = annual operating costs in domestic currency, year t,

C_t^I = operating inputs and material costs, year t,

C_t^W = operating labor cost, year t,

C_t^O = administrative, maintenance and replacement costs, year t,

C_t^f = annual operating costs in foreign currency,

K_t = total investment at market prices, year t,

K_t^n = construction and equipment costs in domestic currency, year t,

K_t^I = machinery and equipment costs in domestic currency, year t,

K_t^m = construction material costs in domestic currency, year t,

K_t^W = construction labor cost, year t,

K_t^a = associated and administrative cost, year t and,

K_t^f = construction and equipment cost in foreign currency.

Next, we proceed to estimate the net effect on the project taking into consideration the shadow price of labor and the shadow price of foreign exchange. From now on we will refer to this alternative as Alternative II. The estimation of the respective profitability indexes are based on the same relations 6.1, 6.2 and 6.3, but adjusting the annual flows B_t, C_t and K_t according to the following relations.

$$B_t^* = B_t^n + B_t^f + \phi B_t^f + V_f \tag{6.9}$$

$$C_t^* = C_t + \phi C_t^f + \lambda C_t^W \tag{6.10}$$

$$K_t^* = K_t + \phi K_t^f + \lambda K_t^W \tag{6.11}$$

$$\phi = (P_s^f - P_o^f)/P_o^f \tag{6.12}$$

$$\lambda = (P_s^W - P_m^W)/P_m^W \tag{6.13}$$

where each additional term is defined as follows.

B_t^* = annual gross production at shadow prices, year t,

C_t^* = annual operating costs at shadow prices, year t,

K_t^* = total investment at shadow prices, year t,

ϕ = foreign exchange premium,

P_s^f = shadow price of foreign exchange,

P_o^f = official foreign exchange rate,

λ = labor premium,

P_s^W = shadow price of labor and,

P_o^W = market price of labor.

Finally, from Alternative II we proceed to identify the distributive shares of benefits and costs imputed to each economic agent associated with the project. We are considering as economic agents the private sector (P), the public sector (G), the wage earners (L) and farmers (A).

The process of identification and assigning of the distributive shares, consists of determining which part of the annual flows B_t^*, C_t^*, and K_t^* are enjoyed or paid by each economic group. This distribution will depend on the way the project is financed and who operates the project.

The assignment of the distributive shares and the estimation of the respective profitability indexes, in terms of consumption, are based on the same relations 6.1, 6.2 and 6.3 but the annual flows B_t^*, C_t^* and K_t^* are redefined according to the following relations:

$$B_t^* = B_t^{*G} + B_t^{*P} + B_t^{*L} + B_t^{*A} \tag{6.14}$$

$$C_t^* = C_t^{*G} + C_t^{*P} + C_t^{*L} + C_t^{*A} \tag{6.15}$$

$$K_t^* = K_t^{*G} + K_t^{*P} + K_t^{*L} + K_t^{*A} \tag{6.16}$$

$$S_t^G = (B_t^{*G} - C_t^{*G} - K_t^{*G})((1 - s_G) + s_G\ P^{inv}) \tag{6.17}$$

$$S_t^L = (B_t^{*L} - C_t^{*L} - K_t^{*L})((1 - s_L) + s_L\ P^{inv}) \tag{6.18}$$

$$S_t^P = (B_t^{*P} - C_t^{*P} - K_t^{*P})((1 - s_P) + s_P\ P^{inv}) \tag{6.19}$$

$$S_t^A = (B_t^{*A} - C_t^{*A} - K_t^{*A})((1 - s_A) + s_A\ P^{inv}) \tag{6.20}$$

$$S_t = S_t^G + S_t^L + S_t^P + S_t^A \tag{6.21}$$

where:

B_t^{*G}, B_t^{*P}, B_t^{*L}, B_t^{*A} = distribution of benefits (B_t^*) towards the public sector, private sector, wage earners and farmers respectively, year t,

C_t^{*G}, C_t^{*P}, C_t^{*L}, C_t^{*A} = distributions of operating costs (C_t^*) towards the public sector, private sector, wage earners and farmers respectively, year t,

K_t^{*G}, K_t^{*P}, K_t^{*L}, K_t^{*A} = distribution of total investment (K_t^*) towards the public sector, private sector, wage earners and farmers respectively, year t,

s_G, s_P, s_L, s_A = marginal propensities to save of the public sector, private sector, wage earners and farmers respectively,

P^{inv} = shadow price of investment and,

S_t = social value of net aggregated consumption, year t.

We must mention that relation 6.20 determines the net present value for our Alternative III. For purposes of estimating the benefit-cost ratio and the internal rate of return the annual flows B_t^*, C_t^*, and K_t^* must be weighted according to relations 6.17, 6.18, 6.19 and 6.20.

2. Results of Alternative I

In this first alternative we proceeded to estimate the indexes of profitability taking as a point of reference the prices as existing in the market. In Appendix B we detail the costs of the projects indicating the more important components of investment.

With respect to the agricultural projects we observe that the investment categories are more or less the same between projects. The share of labor fluctuates between 12 percent for Majes and 19 percent for Jequetepeque. On the other hand the foreign exchange component represents approximately 35 percent of total project costs. The costs corresponding to agricultural development are approximately 30 percent of total cost.

With respect to industrial projects a similar observation holds true, but one nevertheless observes a decrease in the share of labor costs. The share of labor cost fluctuates between 12 percent for the Steel Plant in Chimbote and 7 percent for the Fertilizer Plant in northern Peru. The item for equipment constitutes the largest investment item, equalling on the average 40 percent. The foreign exchange component is highly correlated with the participation of machinery in the total cost of the project. On the other hand mining projects tend to have a high capital intensity, such that this represents at least 60 percent of the proposed investment. The budgeted import requirements are closely linked to this. The cost for the labor utilized during the period of construction represents on the average only 6 percent of the total cost of the project. In Appendix B one can obtain an overview of the annual revenues and operation costs for the selected projects. For the agricultural projects these are specified in Tables B.1 - B.13 and they also provide the annual value of production and yields and costs per hectare for each crop.

The Chira-Piura and Olmos projects have the highest yields per hectare respectively equalling 80,000 and 53,000 soles per year. The exported component of these projects fluctuates between 13 percent for Majes and 29 percent for Chira-Piura. In Table 6.2 we specify the percentages which are destined for exports or will substitute for current imports. With respect to operation costs labor share is calculated to participate on an average of 41 percent. The imported component is not really significant for agricultural projects, equalling less than 1 percent of operation costs.

Table 6.2. Labor costs, foreign exchange cost and returns as a proportion of total investment, operating costs and gross output

Project	Construction Period (Yrs)	Production Period (Yrs)	Labor Costs as a % of Total Investment	Labor Costs as a % of Operating Costs
Chira-Piura	12	57	13.6	41.3
Jequetepeque	9	50	19.5	35.5
Olmos	26	56	15.8	44.4
Majes	14	50	11.9	40.8
Michiquillay	6	20	4.5	19.2
IloII	3	20	12.1	23.3
Cerro VerdeII	4	15	5.8	8.0
Cajamarquilla	4	15	5.4	25.5
Steel Plant	15	21	12.9	10.2
La Pampilla	3	20	7.4	0.6
Yura	3	15	8.7	10.9
Fertilizer	2	15	7.3	4.7

Foreign Exchange Costs as a % of		Foreign Exchange Earnings as a % of
Total Investment	Operating Costs	Gross Production
31.1	0.3	28.9
43.3	0.6	26.0
40.0	0.3	26.8
13.7	0.4	12.4
24.9	27.8	100.0
54.8	43.8	100.0
49.6	9.7	95.0
60.1	30.3	100.0
35.7	1.5	42.6
61.0	1.3	9.4
44.1	0.6	100.0
54.3	0.4	100.0

On the other hand the industrial projects are highly technical and labor costs amount to less than 10 percent of costs of operation. The production of these projects is basically destined to satisfy domestic demand. Nevertheless the fertilizer project substitutes in 100 percent current urea imports. The import requirements of industrial projects fluctuates between 1 percent and 2 percent of the costs of operation.

The mining projects will produce entirely for export purposes. The requirements of goods and services to be imported equal on the average 25 percent of the costs of operation. Labor costs equal approximately 20 percent. In Appendix B we present the flows of costs and benefits associated with the total economic life of these projects selected for further study. The periods of construction have been taken from the feasibility studies and also reflect to some extent the priority assigned to them by the government. The periods of production correspond to the conventional averages for these types of projects and not to the economically useful life of physical assets. For the purposes of the calculation of the net present value, benefit-cost ratio and the internal rate of return we assumed a social rate of discount equal to 10 percent. This value has been estimated following the procedure suggested by Marglin [48] according to the following relationship:

$$i = (1 + v)(s/y)(y/k) \tag{6.22}$$

where:

i = social rate of discount,

$(1+v)$ = negative of the elasticity of marginal utility of consumption,

s/y = saving-output ratio and,

y/k = output-capital ratio.

We assigned a value of 1.25 to the parameter (1+v), which is consistent with the value of the money flexibility estimated by Van de Wetering for Peru [74]. In the study referred to the parameter (1+v) was calculated at the national level as being between -1.01 and -1.44. The value adopted here represents the average of this range.

The savings rate was calculated according to the official statistics of the Central Reserve Bank [5]. The computed value equals 18 percent corresponding to the average of the years 1967 through 1974. It may be observed that this value is consistent with that realized by Christian [12]. On the other hand we assigned a value of 2.2 to the capital-output ratio. This ratio was calculated by Taylor [66] in his estimation of the stock of capital and the rate of return on the stock of capital for Peru. For the purposes of calculating the indexes of profitability we have assumed that both the costs and the benefits correspond to the end of the year of the project. The discounting process starts in year zero. In Table 6.3 we present the net present value according to Alternative I taking as a base existing market prices. The results with respect to agricultural projects indicates the Chira-Piura project as the most profitable. The only project which obtains a negative net present value is the Majes irrigation project. With respect to the industrial projects both the Steel Plant and the La Pampilla oil refinery stand out because of the large value of their net present value where the steel plant actually ranks first.

Table 6.3. Net present value and ranking of the selected projects

Project	Marglin Approach		
	Alternative I	Alternative II (million soles)	Alternative III
Steel Plant	24617.5	42751.8	81654.9
La Pampilla	19679.7	28750.9	54937.7
IloII	5273.9	10312.4	19728.0
Chira-Piura	3149.5	8799.5	8900.3
Olmos	2444.8	5197.3	3934.8
Cajamarquilla	1379.9	5597.8	10763.0
Michiquillay	1359.6	19020.0	36904.0
Jequetepeque	1268.9	4780.7	3965.3
Fertilizer	683.3	3625.2	6924.2
Yura	196.3	65.6	125.6
Majes	-747.8	702.8	-4936.5
Cerro VerdeII	-4509.1	26075.4	51688.9

Little-Mirrlees Approach Alternative IV (million soles)	Ranking			
	Alt. I	Alt. II	Alt. III	Alt. IV
49167.9	1	1	1	1
29130.7	2	2	2	3
11240.5	3	5	5	6
11644.5	4	6	7	5
9101.9	5	8	10	7
6640.2	6	7	6	8
21768.4	7	4	4	4
6566.1	8	9	9	9
3915.1	9	10	8	10
210.8	10	12	11	12
1126.5	11	11	12	11
30373.5	12	3	3	2

Among the mining projects the Ilo refinery obtains the largest net present value. On the other hand the Cerro Verde project has a negative net present value. If we take the twelve projects together we can appreciate from Table 6.3 that the steel plant, the La Pampilla refinery, the Ilo copper refinery and the Chira-Piura irrigation project obtain the first four positions in the ranking whereas the Cerro Verde and Majes projects occupy the last two positions respectively.

In Table 6.4 we present the results of the benefit-cost ratio obtained for the twelve projects selected. With respect to the agricultural projects and mining projects we observe that the ranking of the projects are similar to that obtained for the net present value. On the other hand for the industrial projects, the La Pampilla refinery now has a larger benefit-cost ratio than the Chimbote Steel Plant. This because the investment required for the Steel Plant extension is much larger than that for the La Pampilla refinery. If we take the twelve projects together, then the La Pampilla, Ilo, Chira-Piura and the Steel Plant occupy, in that order, the first places in the ranking. This ranking corresponds to those which were previously obtained for the net present value ranking. The Cerro Verde and the Majes projects again occupy the last places in this ranking.

In Table 6.5 we present the results of the internal rate of return. In the mining sector and industrial sector the ranking obtained is the same as that obtained with the benefit-cost ratio. On the other hand in the agricultural sector the Olmos project now obtains an internal rate of return larger than that obtained for the Chira-Piura project as a result

Table 6.4. Benefit-cost ratio and ranking of the selected projects

Project	Marglin Approach		
	Alternative I	Alternative II	Alternative III
La Pampilla	5.56	6.12	6.13
IloII	2.09	2.67	2.68
Chira-Piura	1.66	2.55	1.82
Steel Plant	1.63	1.93	1.93
Olmos	1.60	2.04	1.41
Jequetepeque	1.31	2.02	1.45
Fertilizer	1.22	1.92	1.92
Yura	1.16	1.04	1.04
Cajamarquilla	1.16	1.49	1.49
Michiquillay	1.05	1.66	1.67
Cerro VerdeII	0.94	1.29	1.31
Majes	0.90	1.09	0.70

Little-Mirrlees Approach Alternative IV	Ranking			
	Alt. I	Alt. II	Alt. III	Alt. IV
6.36	1	1	1	1
2.92	2	2	2	4
3.23	3	3	5	2
2.12	4	6	3	6
2.98	5	4	9	3
2.53	6	5	8	5
2.02	7	7	4	7
1.15	8	12	11	11
1.59	9	9	7	9
1.76	10	8	6	8
1.35	11	10	10	10
1.15	12	11	12	12

of a lesser amount of investment required and because of a larger period of construction. If we take the twelve projects together we observe that the first four places in the ranking are occupied by La Pampilla, Ilo, the Steel Plant and Olmos. The last places are again occupied by Cerro Verde and the Majes irrigation project.

In general we therefore can state that with this alternative there is not a definitive superiority as between agricultural, mining and industrial projects. That is, according to the criteria adopted, there are certain changes in the respective rankings obtained. Both with respect to the net present value, benefit-cost ratio and the internal rate of return criterion the first five positions and the last two positions are taken by the same projects.

We must indicate that while the production of the mining projects were based on prices determined by the international mechanism of supply and demand, the prices for agricultural products are determined to some extent by the domestic government policy aimed at maintaining low prices to the consumer for these products. In the industrial sector the La Pampilla refinery and the Steel Plant have significantly improved their profitability because of recent adjustment in prices. In the initial feasibility studies the internal rates of return for these projects were less than 10 percent.

3. Results of Alternative II

For the computation of the indexes of profitability with respect to this alternative it was necessary to readjust the market prices of labor and foreign exchange. For the determination of the appropriate shadow

Table 6.5. Internal rate of return and ranking of the selected projects

Project	Marglin Approach		
	Alternative I	Alternative II (percentage)	Alternative III
La Pampilla	50.82	58.15	58.27
IloII	21.08	25.69	25.76
Steel Plant	16.57	18.38	18.47
Olmos	14.38	16.65	13.03
Chira-Piura	13.71	21.60	16.13
Fertilizer	13.01	21.40	21.51
Yura	12.33	10.58	10.67
Cajamarquilla	12.10	16.08	20.57
Jequetepeque	12.03	16.10	12.69
Michiquillay	10.55	15.75	15.96
Majes	9.15	10.71	7.93
Cerro VerdeII	8.36	12.71	12.87

Little-Mirrlees Approach Alternative IV (percentage)	Ranking Alt. I	Alt. II	Alt. III	Alt. IV
59.73	1	1	1	1
26.04	2	2	2	3
19.76	3	5	5	5
19.38	4	6	8	7
27.91	5	3	6	2
22.38	6	4	3	4
12.06	7	12	11	12
15.75	8	8	4	9
19.50	9	7	10	6
16.50	10	9	7	8
12.15	11	11	12	11
13.43	12	10	9	10

price of labor we followed the procedure suggested by Marglin [14]. Under this focus we define the shadow wage rate as the approximation to the opportunity cost involved. We do not include in the value of the shadow wage rate the indirect costs and factors related to income distribution. For the purposes of this computation we have assumed that the incentive necessary to mobilize labor from the traditional rural sector towards the modern rural sector or to the modern urban sector will be constant, independent of the amount of mobilization involved. For the estimation of the shadow wage rate we have determined that there exists a difference of 20 percent between wages received in urban areas and rural areas. This percentage has been derived from the statistics of the Ministry of Labor, the office of wage rates which tabulate the minimum wage rates received by urban and rural areas for the different departments of the country. In this form we determined the shadow wage rate as 60 percent of the market wage rate. Subsequently we calculated according to relation (6.13) the premium to be given to labor, which was calculated to equal 0.4. This value allows us to discount the cost of construction and the costs of operation to the extent that they refer to unskilled labor starting with the data underlining the calculations in Alternative I.

In the case of mining and industrial projects we determined the percentage of unskilled labor utilized in the period of construction at only 10 percent of the total labor involved. This value is the result of the visits realized to the zone of these projects where we found that the laborers employed were actually permanent employees of the construction firms. For the period of operation we have assumed that all of the employees were skilled because of the advanced technological aspects involved in the production of these projects. In the case of agricultural projects we have assumed that 20 percent of labor was unskilled during the period of construction and 100 percent during the period of operation.

Peru has utilized since 1968 a rigidly controlled system of foreign exchange. This nonmarket oriented allocation of scarce foreign exchange has tended to protect domestic industries by means of tariffs and increased restrictions on the importation of goods and services. Even with such measures the economy continues to suffer a deficit on the current balance of trade, perhaps because of the actual structure of production of the country. The increasing public debt has also been a strategic variable influencing the availability of foreign exchange. The annual repayments of the foreign debt now equal 50 percent of exports earnings and are projected to increase beyond that.

Taking this into consideration we have estimated conservatively that the shadow price for foreign exchange will fluctuate between 1.5 and 1.7 times the actual market rate. Given the statistical limitations it was not possible to estimate above value according to more refined methodological procedures but nevertheless we must mention that the application of relationship 3.17 as formulated by Bruno for these twelve projects yielded a value of 2.0 as the resource cost of generating one dollar of foreign exchange. The foreign exchange premium has been determined according to relation 6.12 as being equal to 0.5. This value allows us to discount the costs of construction and the costs of operation the imported or exported components given the initial results obtained under Alternative I.

In Tables 6.3, 6.4, and 6.5 we list the results obtained for the net present value, the benefit-cost ratio and the internal rate of return for the twelve projects selected. With respect to the agricultural projects the three indexes of profitability maintain the same ranking. However the Chira-Piura project now stands out as being very profitable. These results are to be expected because of the similarity between the employment and balance of payments effects. It is worth mentioning that the Majes irrigation project now has a positive index of profitability. In the industrial projects the benefit-cost ratio and the internal rate of return have the same ranking, where the La Pampilla refinery project occupies the first place. On the other hand the net present value ranking again puts the Chimbote Steel Plant as first. The ranking under Alternative II is therefore exactly the same as that ranking obtained with the profitability indexes calculated under Alternative I. Nevertheless, while the industrial projects improve their indexes of profitability the Yura cement project reflects a decrease in profitability because of the negative effect of the shadow exchange rate. The mining projects also maintain their similar ranking with respect to the profitability indexes calculated under Alternative I.

When we take the twelve projects together we see that the net present value ranking takes the first four spots away from the agricultural projects, nevertheless, in the benefit-cost ratio ranking the third and fourth place are occupied by Chira-Piura and Olmos irrigation projects.

The internal rate of return ranking does not affect the first three positions but now assigns the Fertilizer project as being the fourth most profitable project. As a final observation relative to the analysis implied in Alternative II we must indicate that the mining projects are the most favored because the premium of foreign exchange is applied to 100 percent of their production. As can be seen that the Cerro Verde project now occupies the third place in the ranking in terms of net present value, when under Alternative I it occupied the last place with a negative net present value. The reestimated price for labor increases the profitability of agricultural projects but it is not sufficient to offset the foreign exchange effect of mining projects.

4. Results of Alternative III

The first step in the estimation of the indexes of profitability of this alternative consist in the assignment of costs and benefits as between economic groups that participate in the project. For the agricultural projects the value of annual production (B_t) has been allotted to farmers (B_t^{*A}) because they are the owners of the land and also work the land and hence receive all of the benefits. In the case of the Chira-Piura and the Jequetepeque irrigation projects the agricultural income foregone is already subtracted from B_t^{*A}. On the other hand the premium to be allotted to the exported component of production or the import substituted for (ϕB_t^f) has been alloted to the government (B_t^{*G}) because the public sector pays to the farmers the official exchange rate and retains for itself the surplus. The cost of construction, equipment and engineering (K_t) are allotted to the government (K_t^{*G}) because the implementation of the project is undertaken by the public sector. Similarly we have imputed to the government the additional costs related to the premium to be paid for the imported component (ϕK_t^f) associated with the investment. On the other hand the premium associated with unskilled labor ($0.2\lambda K_t^W$) has been imputed to workers. The coefficient 0.2 corresponds to the percentage of unskilled labor utilized in these projects during the stage of construction.

We must indicate that normally public projects are financed under the mode of "pari passu" operation. That is part of the project is financed by international institutions and credit suppliers and part by the national government. The allocation of resources on the part of the government is realized partially by available public funds and rarely does one create a specific tax so as to finance a specific project. With this we want to indicate that the private sector does not directly absorb the financing of a public project. Nevertheless we assume that the private sector indirectly finances part of the national component of investments, equivalent to the annual increment in the capital transfer which receives the sector responsible for the project, either a ministry or a public enterprise from the treasury. We assume that the resources of the treasury are obtained via taxes.

For the agricultural sector we have determined that according to the budgetary allotments in the period 1968-1975 [53] that the average annual increase in funds obtained from the treasury represent 9 percent of capital expenditures. This percentage distributed between all of the projects in the agricultural sector determines that part financed indirectly by the private sector (K_t^{*P}).

The amounts allotted to the private sector are on the average not very significant. For the agricultural sector projects they represent less than 2 percent of total costs. The inclusion of the private sector given the foregoing assumption can be easily revocable but we thought it convenient to include the private sector in this type of analysis because the government could create on a short run basis legal disposition either in the form of a tax or a loan specifically aimed at the financing of a public project. In this case the private sector then must assume the responsibility of financing the project.

With respect to the cost of operation (C_t) we have imputed direct cost of production to the farmers (C_t^{*A}) because they are the owners of the land. The premium for unskilled labor (λC_t^W) is equally allotted to farmers whereas the premium related to foreign exchange (ϕC_t^f) is imputed to the government. The salvage value and working capital (V_t) are assigned to the government because the works are of a public character and the working capital is provided by government institutions. The respective distributive share are found in Table 6.6.

Once one has calculated the assignment of costs and benefits, B^*, C^* and K^* between the different economic groups we can then determine the distributional shares S^G, S^A, S^L and S^P in terms of consumption generated according to the proportions that each of these groups allot for consumption and investment. For this purpose we have determined the shadow price of investment according to the following relation:

$$P^{inv} = \frac{(1 - s)q}{i - sq} \qquad (6.23)$$

where

Table 6.6. Present value[a] of benefits and costs in year zero and distributive shares

Project	Present Values: Total Output	Total Investment	(Public) (million soles)	(Other)
Chira-Piura	23900.9	4761.5	4706.0	55.5
(distributive shares)	(B^{*A})		(K^{*G})	(K^{*P})
Jequetepeque	16950.1	4109.5	(4052.6)	(56.9)
(distributive shares)	(B^{*A})		(K^{*G})	(K^{*P})
Olmos	15754.2	4057.2	(4016.8)	(40.4)
(distributive shares)	(B^{*A})		(K^{*G})	(K^{*P})
Majes	14199.5	7724.4	(7595.8)	(128.6)
(distributive shares)	(B^{*A})		(K^{*G})	(K^{*P})
Michiquillay	48243.5	25662.8	(24525.5)	(1137.3)
(distributive shares)	(B^{*A})		(K^{*G})	(K^{*P})
IloII	14683.6	4858.5	(4764.1)	(94.4)
(distributive shares)	(B^{*A})		(K^{*G})	(K^{*P})
Cerro VerdeII	107334.6	71197.8	(67331.8)	(3866.0)
(distributive shares)	(B^{*A})		(K^{*G})	(K^{*P})
Cajamarquilla	15283.0	8827.5	(8662.8)	(164.7)
(distributive shares)	(B^{*A})		(K^{*G})	(K^{*P})
Steel Plant	136848.0	38774.7	(38539.0)	(235.7)
(distributive shares)	(B^{*A})		(K^{*G})	(K^{*P})
La Pampilla	82868.6	4312.0	(4249.2)	(62.8)
(distributive shares)	(B^{*A})		(K^{*G})	(K^{*P})
Yura	2831.0	1207.1	(1200.5)	(6.6)
(distributive shares)	(B^{*A})		(K^{*G})	(K^{*P})
Fertilizer	7645.6	3080.9	(3067.7)	13.2
(distributive shares)	(B^{*A})		(K^{*G})	(K^{*P})

[a]Social rate of discount = 10%.

[b]Foreign exchange premium = 50% of the market rate.

[c]Labor premium = 40% of the market rate.

Operating Costs	Foreign Exchange Premium, Net[b]	Labor Premium[c] Construction Period	Labor Premium[c] Production Period	Salvage Value and Working Capital
15991.8 (C*A)	2764.5 (B*G)	70.5 (-K*L)	2815.1 (-C*A)	1.9 (B*G)
11573.1 (C*A)	1807.1 (B*G)	60.4 (-K*L)	1644.3 (-C*A)	1.6 (B*G)
9252.2 (C*A)	1065.6 (B*G)	63.0 (-K*L)	1623.9 (-C*A)	-
7232.8 (C*A)	209.6 (B*G)	91.6 (-K*L)	1148.6 (-C*A)	9.9 (B*G)
21471.9 (C*A)	17639.3 (B*G)	21.1 (-K*L)	-	251.0 (B*G)
4604.7 (C*A)	5107.7 (B*G)	23.7 (-K*L)	-	53.4 (B*G)
42242.4 (C*A)	30417.2 (B*G)	167.3 (-K*L)	-	1596.5 (B*G)
5320.4 (C*A)	4198.8 (B*G)	19.3 (-K*L)	-	244.8 (B*G)
74358.0 (C*A)	17969.5 (B*G)	164.8 (-K*L)	-	902.4 (B*G)
58938.7 (C*A)	9057.9 (B*G)	13.3 (-K*L)	-	62.2 (B*G)
1442.2 (C*A)	-134.9 (B*G)	4.2 (-K*L)	-	14.6 (B*G)
4030.4 (C*A)	2932.9 (B*G)	9.0 (-K*L)	-	149.0 (B*G)

s = marginal propensity to save,

q = marginal rate of return,

i = social rate of discount and,

P^{inv} = shadow price of investment.

The value of the parameter q has been determined as equal to 0.15 according to Taylor [66] for Peru. The value of 0.41 assigned to the parameter s comes from the consumption function obtained in the model constructed by Christian [12]. The solution of relationship (6.23) yields a value for the price of investment equal to 2.3 if the social rate of discount equals 10 percent.

The social value of the consumption generated by the farmers is given by relation (6.20) where the second term on the right $((1-s_A) + s_A P^{inv})$ gives us the social weight assigned to consumption by farmers. Given a marginal propensity to save of farmers equal to 0.13 and a shadow price of investment equal to 2.3 the distributive share of farmers in terms of consumption generated can be expressed as follows:

$$S_t^A = 1.17\ (B_t^{*A} - C_t^{*A} - K_t^{*A}) \tag{6.24}$$

Also the social value generated by the public sector corresponding to a marginal propensity to save equal to 0.70 can be expressed according to relation (6.17) as follows:

$$S_t^G = 1.91\ (B_t^{*G} - C_t^{*G} - K_t^{*G}) \tag{6.25}$$

The distributive share corresponding to the private sector with a marginal propensity to save equal to 0.30 can be expressed according to relation (6.19) as follows:

$$S_t^P = 1.39 \ (- K_t^{*P}) \tag{6.26}$$

Finally the distributive share corresponding to the wage earners with a marginal propensity to save equal to 0.12 can be expressed according to relation (6.18) as follows:

$$S_t^L = 1.16 \ (- K_t^{*L}) \tag{6.27}$$

Given the statistical limitations it was not possible to estimate above values according to more refined methodological procedures but nevertheless we must mention that those parameters have been calculated following one of the procedures suggested by Marglin [14]. In the case of the marginal propensity to save of the public sector we have taken as a first approximation the ratio of incremental investment (28.5 billions of soles) to incremental expenditure (41 billions of soles) for the period 1969-1974 [5]. This ratio determines the value of 0.70 assigned to s_G. In the case of the marginal propensity to save of the private sector we have taken the ratio of incremental retained earnings (6.8 billions of soles) to incremental after-tax profits (22.7 billions of soles) for the same period [54]. This ratio determines the value of 0.30 assigned to s_p. With respect to the marginal propensities to save of farmers and wage earners we have taken as reference the ratio of incremental retained earnings to after-tax profits for several agroindustries [54]. This ratio determines the values of 12 percent and 13 percent for s_L and s_A respectively. In Table 6.7 we listed all the parameters utilized under this alternative.

Table 6.7. Values of general parameters

Parameter	Value
Marginal propensity to import	$m = 0.25$
Marginal propensity to save	$s = 0.41$
Return to capital	$g = 0.15$
Capital output ratio	$k/y = 2.2$
Negative of the elasticity of marginal utility of consumption	$(1+v) = 1.25$
Social rate of discount	$i = 10\%$
Marginal propensity to save:	
public sector	$s_G = 0.70$
private sector	$s_P = 0.30$
wage earners	$s_L = 0.12$
farmers	$s_A = 0.13$
Weigh on aggregate consumption:	
public sector $[(1-s_G) + s_G P^{inv}]$	$C^G = 1.91$
private sector $[(1-s_P) + s_P P^{inv}]$	$C^P = 1.39$
wage earners $[(1-s_L) + s_L P^{inv}]$	$C^L = 1.16$
farmers $[(1-s_A) + s_A P^{inv}]$	$C^A = 1.17$
Unskilled labor premium	$\lambda = 0.4$
Foreign exchange premium	$\phi = 0.5$

The indexes of profitability net present value, benefit-cost ratio and the internal rate of return have been determined for the agricultural projects according to relations 6.24 - 6.27. The assignment of the costs and benefits B^*, C^* and K^* for the industrial and mining projects we assumed an homogeneous form because all of these projects are in the hands of respective public authorities.

The value of annual production (B_t) and the premium of foreign exchange (ϕB_t^f) have been assigned to the public sector (B_t^{*G}). Equally we impute the total cost of the project (K_t) and the premium correspondent to the imported component (ϕK_t^f) to the public sector. On the other hand the premium for unskilled labor ($0.10\ \lambda K_t^W$) is assigned to the wage earners (K_t^{*L}). The coefficient 0.10 corresponds to the percentage of unskilled labor that intervenes in the period of construction.

The amounts imputed to the private sector for the mining projects correspond to an annual increase of public fund equivalent to 22 percent of total capital expenditure. The corresponding amounts represent on the average six percent of total costs.

For the industrial projects we determined an annual increase from public fund equivalent to 5 percent of capital expenditures. The corresponding quantities represent on the average 1 percent of total costs. The costs of operation (C_t) are imputed entirely to the public sector and also the premium related to the imported component.

With respect to mining and industrial projects only the public sector, the private sector and wage earners are to be identified as participants in costs and benefits. Because of this the profitability indexes such as the net present value, benefit-cost ratio and the internal rate of return can be calculated on the basis of the relationship (6.25), (6.26) and (6.27).

The results obtained for the net present value are listed in Table 6.3 and we also list their corresponding ranking. Within the agricultural projects the Chira-Piura project maintains its first place but the Jequetepeque project moves up one place and leaves the Olmos project now in third place. This change is the result of the larger capital intensity of the Olmos project. Observe that the net present value of the agricultural projects has decreased with respect to the values obtained under Alternative II. This decrease is caused by a disproportional increase in capital expenditures with respect to the benefits. That is to say while the investment costs and the premium to be paid for foreign exchange have increased by 90 percent the benefits have increased by 17 percent due to the weight given to consumption by farmers. The Majes irrigation project is again the lowest in terms of this ranking and once again obtains a negative net present value.

Within the industrial projects we maintain the same ranking as we obtained under Alternative I and Alternative II but the net present value has increased considerably because both the costs and benefits have increased by 90 percent but the premium of foreign exchange is what determines this increase because a very high percentage of production is destined for exports. In the mining projects we observe a very fundamental change. The Cerro Verde project now obtains the first place. If we take the 12 projects together we find that the Chimbote Steel Plant, the La Pampilla oil refinery, the Cerro Verde and Michiquillay mining projects now obtain the first four positions of the ranking obtained for the net present value. The agricultural projects now stand around the third section of the ranking.

The mining and industrial projects have improved their positions in terms of the absolute value of net present value and proportionally to the weight given to consumption by the public sector. The agricultural projects on the other hand have not been able to compensate for the increased investment costs and the increased premium of foreign exchange and labor. That is the weighting factor assigned to the government is greater in the construction phase than in the weight given to the consumption of farmers during the operation phase.

In absolute terms the range of net present value is very large, oscillating between 81 billion soles for the steel plant and -4.9 billion soles for the Majes irrigation project. The results in terms of the benefit-cost ratio and the internal rate of return are presented in Tables 6.4 and 6.5.

For the agricultural projects the benefit-cost ratio maintains the ranking obtained for the net present value criterion, nevertheless for the internal rate of return the Olmos project again occupies the second place. For the industrial projects both the benefit-cost ratio and the internal rate of return have similar rankings. For the mining projects the Ilo refinery again occupies the first position and Cerro Verde again passes to the last position. If we take all the projects together then we see that the La Pampilla, Ilo, the Steel Plant and the Fertilizer project occupy the first four positions of the benefit-cost ratio ranking and for the internal rate of return criterion the Steel Plant is displaced by the Cajamarquilla project. It is important to observe that the benefit-cost ratio results do not produce a large range of variation between projects. Furthermore the indexes obtained by the utilization of the benefit-cost ratio are quite similar to Alternatives I and II. On the other hand the net present value results differ considerably from those obtained when calculating Alternative II.

On the other hand we observe that the present value criterion improve the projects operated-maintained by the public sector. The investment costs increased by 89 percent which is the average of the weights assigned to the consumption of the public sector whereas the benefits increased by 91 percent, in which the premium assigned to foreign exchange has the principal influence. The larger projects with the larger flow of annual benefits are those which mostly influenced in this alternative. With respect to agricultural projects the investment costs increased more than benefits because of a disproportional increase between investment costs and benefits. In general all projects except Majes were classified as socially profitable under Alternative III.

5. Sensitivity analysis

The application of a sensitivity analysis has been done only for Alternative III according to the method proposed by ONUDI [14]. First we have assumed as representative value for the flexibility of the marginal utility of income the extreme values lying between 1.01 and 1.44 estimated by Van de Wetering [73]. The estimation of the social rate of discount corresponding to these values is based on relation (6.22) which then gives us two values for i, 8 percent and 12 percent respectively.

Subsequently we proceeded to determine the shadow price of investment according to relation (6.23). The values found were 4.78 and 1.51 respectively corresponding to rates of discount equal to 8 percent and 12 percent. Having the values for the shadow price of investment we have recalculated the social weighting of consumption for each participating group. This has been done according to the second term on the right hand side of relations 6.17 - 6.20.

With respect to the shadow price of labor we have included the direct opportunity cost and also induced effects according to the following relationship

$$SWR^* = Z + s_p (P^{inv} - 1) W \qquad (6.28)$$

where:

Z = direct opportunity cost of labor,

s_p = marginal propensity to save of the private sector,

P^{inv} = shadow price of investment,

W = market wage rate, and,

SWR^* = shadow price of labor including indirect effects.

On the other hand we have increased from 1.5 to 1.7 the shadow price of foreign exchange. In Table 6.8 we present jointly the parameters which will serve as a basis for the reestimation of the profitability indexes of net present value and the benefit-cost ratio. We are considering six analytical variants which are the results of separate combinations between the social rate of discount, the shadow wage rate and

Table 6.8. Values of the parameters considered for the sensitivity analysis

Parameters	Variants I	II	III
Negative of the elasticity of marginal utility of consumption (1 + v)	1.25	1.25	1.44
Social rate of discount (i)	0.10	0.10	0.12
Shadow price of investment (p^{inv})	2.30	2.30	1.31
Weights on aggregate consumption:			
Public sector (C^G)	1.91	1.91	1.36
Private sector (C^P)	1.39	1.39	1.15
Wage earners (C^L)	1.16	1.16	1.06
Farmers (C^A)	1.17	1.17	1.07
Shadow wage rate as a percentage of market rate (SWR)	60.	99.	60.
Shadow exchange rate as a percentage of official exchange rate (SER)	150.	170.	150.

Variants		
IV	V	VI
1.44	1.01	1.01
0.12	0.08	0.08
1.51	4.78	4.78
1.36	3.65	3.65
1.15	2.13	2.13
1.06	1.45	1.45
1.07	1.49	1.49
75.	60.	173.
170.	150.	170.

the shadow price for foreign exchange. Referring to the same Table 6.8, we have that variants I, II and III correspond to rates of discount equal respectively to 8 percent, 10 percent and 12 percent. The values assigned to the shadow wage rate and the shadow price for foreign exchange have been set at 0.6 and 1.5 respectively. In variants IV, V and VI we utilized the same rates of discount but we included in the shadow wage rate the indirect effects and we increased the shadow price for foreign exchange to 1.7. One should observe that the weighting of the consumption of each participating group (C^G, C^P, C^L, C^A) will vary when we change the rate of discount.

The results for variants I, II and III are presented for the twelve projects in Table 6.9. To the extent that the social rate of discount decreases from 12 percent to 8 percent the shadow price of investment increases from 1.51 to 4.78. This implies that with larger rates of discount the weighting of consumption of the different economic groups come closer together. That is to say there no longer exists much discrepancy between the values for C^G, C^A, C^P, and C^L.

For a value of i equal to 12 percent the consumption weight of government consumption and agricultural consumption equal 1.36 and 1.07 respectively. But when we assign to i a value equal to 8 percent the weight given to public consumption increases because of the effect of the price of investment to 3.65 whereas the weighting of consumption for farmers only increases to 1.45. This demonstrates the great degree of sensitivity between the shadow price of investment and the weights assigned to consumption by different groups when we vary the rate of discount. The group mostly affected are the farmers, because while their benefits are quantified by the value in consumption, their investment costs are weighted by the consumption generated by the government, which is always larger. This indicates that the performance of the agricultural projects will improve to the extent that the social rate of discount i increases.

With respect to the agricultural projects we observe that when the social rate of discount decreases the net present value increases, but nevertheless the benefit-cost ratio decreases because the capital cost increases in a larger proportion than the benefits because of the differential weighting given to government consumption. The ranking of agricultural projects always maintains the Chira-Piura project as the most profitable. Nevertheless one observes that to the extent that the social rate of discount i increases the Olmos project displaces the Jequetepeque project because of the longer period of construction associated with the Olmos project.

The industrial and mining projects increase both the net present value and the benefit-cost ratio when the social rate of discount decreases. The ranking of these projects is not altered for the situation studied under Alternative III. In variant IV, V and VI we maintain the values for the social rate of discount but the shadow wage rate was determined according to relation 6.28. As we can observe that to the extent the price of investment increases the shadow price of labor which allows for the inclusion of indirect effects will also increase. When we assume a social rate of discount equal to 8 percent the shadow wage rate represents 1.73 times the market wage. This indicates that the indirect effects tend to increase the shadow wage rate according to the values obtained for the shadow price of investment. This implies that for certain values of the rate of discount i, the shadow wage rate may be actually larger than the market wage.

With respect to the agricultural projects we can compare in Table 6.8 the values of the shadow wage rate when one considers the indirect effects associated with the use of labor. We observe clearly that both the net present value as well as the benefit-cost ratio decrease because of the inclusion of indirect effects in the shadow wage rate. One observes that the Olmos project now obtains a negative net present value because its labor costs increased by 73 percent. The Chira-Piura and Jequetepeque projects partially neutralize the effect of the shadow wage rate because of the premium given to foreign exchange.

On the other hand the mining and industrial projects increase their net present value and benefit-cost ratio. In Table 6.9 one can compare the results for different rates of discount. Generally we observe that the mining and industrial projects are favored because of the premium given to foreign exchange. The indirect effects as included in the computation of the shadow wage rate do not influence this result very much because of the low labor intensity of these projects. The agricultural projects on the other hand are influenced by the weight given to consumption by the government. This negative influence is intensified for smaller values of the social rate of discount. Equally the inclusion of indirect effects in the shadow wage rate decreases the profitability

Table 6.9. Sensitivity analysis results, Marglin Alternative III

Project	Social rate of discount					
	8% (Var. V)		10% (Var. I)		12% (Var. III)	
	Net Present Value[a]	Benefit Cost Ratio	Net Present Value[a]	Benefit Cost Ratio	Net Present Value[a]	Cost Ratio
Steel plant	241427	2.31	81655	1.93	36172	1.63
Cerro Verde II	175850	1.52	51689	1.31	11751	1.10
Michiquillay	113963	2.01	36904	1.67	14021	1.38
La Pampilla	85413	4.97	54938	6.13	38321	6.30
Ilo II	50260	3.15	19728	2.68	7675	1.94
Cajamarquilla	31572	1.72	10763	1.49	8683	2.06
Fertilizer	17914	2.20	6924	1.92	5189	2.00
Chira-Piura	16368	1.70	8900	1.82	4252	1.62
Jequetepeque	9508	1.53	3965	1.45	1706	1.29
Olmos	7764	1.34	3935	1.41	2043	1.35
Yura	1111	1.20	126	1.04	-153	0.92
Majes	-10195	0.70	-4936	0.71	-3611	0.64

[a] Million soles.

Social rate of discount					
8% (Var. VI)		10% (Var. II)		12% (Var. IV)	
Net Present Value	Benefit Cost Ratio	Net Present Value	Benefit Cost Ratio	Net Present Value	Benefit Cost Ratio
251647	2.27	95078	2.01	42744	1.69
212927	1.56	72197	1.39	25361	1.20
131859	2.11	49765	1.86	21239	1.55
95072	4.88	61853	6.30	41267	6.21
54345	3.01	23453	2.83	9776	1.98
33750	1.68	13745	1.57	10931	2.22
22394	2.37	9153	2.11	7126	2.26
5358	1.21	7728	1.66	4259	1.58
3315	1.17	3416	1.36	1735	1.28
-277	0.99	2798	1.27	1853	1.29
491	1.08	32	1.01	-233	0.89
-18750	0.50	-5851	0.64	-3941	0.62

of these projects because on the average they are quite intensive in the use of labor.

6. The Little and Mirrlees approach

The social evaluation of projects according to the method proposed by Little and Mirrlees [46] will be done under the assumptions and adjustments adopted as for Alternative II proposed by Marglin. That is to say we will maintain similar values assigned for the shadow price of labor, the shadow price of foreign exchange and the rate of discount. Nevertheless we must remember that in Marglin's method the numeraire is consumption, whereas in Little and Mirrlees method the numeraire is investment. The additional adjustment required is the conversion of the consumption generated by employment during the construction period and during the period of operation in terms of investment. In other words the cost of labor during the construction and operation periods must be expressed in terms of investment.

The estimation of the respective indexes of profitability are based on the same relationships 6.1, 6.2 and 6.3 as calculated for Alternative II as proposed by Marglin's method. Except that the annual flows C_t^* and K_t^* in relations 6.10 and 6.11 are redefined so as to express the cost of labor in terms of investment. We must observe that relation 6.9 does not change. We then can rewrite C_t^* and K_t^* as:

$$C_t^{**} = C_t^* + \phi C_t^f + C_t^{SWR}/P^{inv} \tag{6.29}$$

$$K_t^{**} = K_t^* + \phi K_t^f + K_t^{SWR}/P^{inv} \tag{6.30}$$

where:

C_t^{**} = annual operating costs in terms of investment, year t,

C_t^{*} = annual operating costs at shadow prices excluding labor costs, year t,

C_t^{f} = annual operating costs in foreign currency, year t,

ϕ = foreign exchange premium,

C_t^{SWR} = total operating labor costs valued at shadow prices, year t,

P^{inv} = shadow price of investment,

K_t^{**} = total investment in terms of investment, year t,

K_t^{*} = total investment at shadow prices excluding labor costs, year t,

K_t^{f} = construction and equipment cost, in foreign currency, and

K_t^{SWR} = construction labor costs valued at shadow prices, year t.

The results obtained for the net present value can be found in Table 6.3 where we can compare the results with the alternative proposed by Marglin. As we can see all projects increase their net present value according to the extent that labor is involved in the period of construction and operation. Agricultural projects because they are more intensive in the use of labor, increase their profitability in a greater proportion than the projects in the mining and industrial sector.

The ranking of the net present value is similar to that as obtained by Marglin's Alternative II except that the Cerro Verde mining project now occupies the second position displacing the La Pampilla refinery project to a third place, because the Cerro Verde project does involve a larger percentage of utilization of labor in both the construction and operation stage of the project.

The ranking of the benefit-cost ratio are listed in Table 6.4 and this can be compared with the results obtained in the Alternative II of Marglin's method. Observe that the first five positions under both alternatives are taken by the same projects but Chira-Piura and the Olmos irrigation project now occupy the second and third place respectively.

The results for the ranking of the internal rate of return are presented in Table 6.5. The ranking obtained reserves for the first five places the same projects as under Alternative II for Marglin, except that the Chira-Piura project pushes the Ilo copper refinery project to third place. In general one observes that Alternative IV increases the indexes of profitability of all projects according to their percentages of utilization of labor. The agricultural projects because they are intensive in labor are favored in a larger proportion than the mining and industrial projects. The ranking of the projects within the same sector are the same as under Alternative II and IV, but when we compare the twelve projects jointly the agricultural projects tend to improve their relative position.

B. The Social Marginal Productivity of Capital

The social marginal productivity of capital criterion as formulated by Chenery [11] tries to evaluate the profitability of a project according to its contribution to the national product and to the balance of payments. The theoretical basis for this method of evaluation were presented earlier. In this section we will proceed to apply the social marginal productivity criterion to twelve projects. In general we can define the social marginal productivity by the following relationship:

$$SMP = \frac{V}{K} - \frac{C}{K} + r\frac{B}{K} \qquad (6.31)$$

Where the term V/K is the output-capital ratio, the second term C/K is the domestic cost-capital ratio and the last term rB/K is the balance of payments effect per unit of capital.

Before proceeding to define the variables involved in each of the terms in relation (6.31) we must state that the social marginal productivity criterion will be applied under three alternatives. In Alternative I the variables of relation (6.31) will be considered without taking into account the time value of capital. For the situation of annual variables these will be referred to as the average annual value. In Alternative II the total cost of the project K as well as the annual flows V and C are expressed in terms of their annual equivalent values. In Alternative III the total cost of the project as well as the variables V and C are expressed in terms of their annual equivalent values but we also include the shadow price for labor. Taking these considerations into account we can define the variables of relation (6.31) for Alternative I as:

SMP = annual increment in national income per unit of investment plus the balance of payments effect,

K = total cost of investment,

V = average annual domestic output = $X + E - M_i$,

X = average annual gross output,

E = externalities,

M_i = imported materials,

C = average annual domestic cost = $L + M_d + 0$,

L = average annual labor cost,

M_d = average annual domestic materials costs,

0 = average annual all other cost including maintenance and replacement,

B = balance of payments effect, and,

r = premium accounting for the overvaluation (subvaluation) of the official exchange rate.

The inconvenience of the first alternative is related to the fact that one does not consider the time value of capital. First we consider the total cost of the project without considering the gestation period. In other words one does not discriminate between projects which may take one, two or more years. Also by taking the annual benefits and annual costs as an annual average we lose sight of the period of production on useful economic life of the project. That is, we do not consider whether one project or another project has a longer period of productive life.

In the case of projects within the same sector there probably will not be too much of a distortion because one might reasonably assume equal economic life for all projects. But when we evaluate projects for different sectors the economic horizon is likely to be quite different. Also in Alternative I one does not take into account whether the annual flows are larger in, for example, earlier years than in later years.

In Alternative II we try to correct for these deficiencies. Hence we redefine the social marginal productivity criterion according to the following relationships:

$$SMP^* = \frac{V^*}{K^*} - \frac{C^*}{K^*} + r\frac{B^*}{K^*} \tag{6.32}$$

$$K^* = \sum_{t=1}^{n} \frac{K_t}{(1+i)^t} \cdot a \tag{6.33}$$

$$V^* = \sum_{t=1}^{n} \frac{V_t}{(1+i)^t} \cdot a \tag{6.34}$$

$$C^* = \sum_{t=1}^{n} \frac{C_t}{(1+i)^t} \cdot a \tag{6.35}$$

$$a = \frac{i\ (1+i)^n}{(1+i)^n - 1} \tag{6.36}$$

and with each additional term defined as:

SMP^* = equivalent annual increment in national income and the balance of payments effect per unit of the equivalent annual value of investment,

K^* = equivalent annual value of total investment,

V^* = equivalent annual value of domestic output,

C^* = equivalent annual value of domestic costs,

a = capital recovery factor for a given discount rate and project life,

i = rate of discount and,

B^* = balance of payments effect.

Finally Alternative III considers the shadow price of labor and also expresses the initial investment and the annual values V, C and B in their equivalent annual values. Because of this expression (6.32) can now be redefined as follows:

$$SMP^{**} = \frac{V^*}{K^{**}} - \frac{C^{**}}{K^{**}} + r\frac{B^{**}}{K^{**}} \tag{6.37}$$

and with each additional term defined as:

SMP^{**} = equivalent annual increment in national income and the balance of payments effect per unit of the equivalent annual value of investment considering the shadow wage rate,

K^{**} = equivalent annual value of investment considering the shadow wage rate,

V^* = equivalent annual value of domestic output, and,

C^{**} = equivalent annual value of domestic costs considering the shadow wage rate.

On the other hand the total balance of payments effect is given by the following relationships:

$$B(K, X) = a\, B_1\,(K) + B_2\,(X) + B_3\,(X) \tag{6.38}$$

$$B_1 = m_i\, K - mz\,(1 - m_i)\, K \tag{6.39}$$

$$B_2 = e\,(1 - \overline{mp})\, X - c\,\overline{mp}\, X - g\,(\overline{mp}' - \overline{mp}) \tag{6.40}$$

$$B_3 = -\, mz\, B_2 - mzf\,(1 - \overline{mp}) \tag{6.41}$$

where:

B = balance of payments effect, defined as a function of X and K,

B_1 = investment effect, defined as a function of K,

B_2 = direct operating effect, defined as a function of X,

B_3 = indirect operating effect, defined as a function of X,

a = capital recovery factor,

m_i = proportion of total investment requiring imports,

m = marginal propensity to import,

z = the investment multiplier = $1/m + s$,

s = marginal propensity to save,

e = proportion of output in exports or import substitutes,

$\overline{mp}$ = imports per unit of outputs,

c = proportion of output going to domestic markets,

g = proportion of output replacing current consumption,

$\overline{mp}'$ = imports per unit of output replaced, and,

f = proportion of output financed by inflationary mean.

We must observe that the sum of the parameters e, c and f should be equal to unity. Also we have to remember that because the balance of payments effect is related to K and X therefore B^* and B^{**} must be computed according to the redefined relations for K and X. That is B is defined for Alternative II and Alternative III as follows:

B^* = the annual value effect on the balance of payments valued at market wages, and,

B^{**} = the annual value effect on the balance of payments valued at shadow wages.

On the other hand we must mention that we only have considered the shadow price of labor and not that for foreign exchange because the over or undervaluation of the exchange rate is already included in r.

In Alternative I we consider the initial investment K of the projects as absolute figures ignoring any possible discounting process as related to the period of construction. The value added of national factors (V) is determined as the difference between the annual average production (X) and the annual average value of imported inputs (m_i). The values for m_i have been extracted from the feasibility studies. We do not consider internal and external economies of the project, and hence we have assigned a value of zero to E. The total cost of the national factors of production (C) is given by the sum of the annual average cost of labor (L), the inputs and national materials (M_d) and the fixed costs of operation (O).

In Table 6.10 we present for the twelve projects the values obtained for the capital turnover coefficient (V/K), the total cost of operation per unit of investment (C/K) and the percentage margin of social value over cost (V-C)/V. The effect on the balance of payments B have been determined according to relation (6.38). The direct effects of investment on the balance of payments B, are defined according to relation (6.39). The imported component of the initial investment (m_i) has been extracted from the feasibility studies. The marginal propensity to import (m) has been determined as point 0.25, which is consistent with the values estimated in the econometric models constructed for the Peruvian economy by Christian [12] and Thorbecke and Condos [69]. The investment multiplier ($z = 1/m+s$) has been estimated as 1.52 where the value (s) represents the marginal propensity to save defined and determined earlier as equal to 0.41. For the agricultural projects the direct effect of the initial investment on the balance of payments is given by the following relations:

Table 6.10. Social marginal productivity of investment[a], market wages and alternatives shadow exchange rates (Alternative I)

Project	(A) Capital Turnover (V/K)	(A) Capital Turnover R[b]	(B) Cost Ratio (C/K)	(C) Value Margin (V-C)/V
La Pampilla	2.99	1	1.90	0.36
IloII	0.35	7	0.07	0.80
Steel Plant	0.54	3	0.28	0.48
Jequetepeque	0.61	2	0.35	0.42
Fertilizer	0.39	5	0.20	0.49
Cajamarquilla	0.25	11	0.08	0.68
Olmos	0.41	4	0.24	0.41
Cerro VerdeII	0.24	12	0.10	0.58
Michiquillay	0.26	10	0.13	0.52
Chira-Piura	0.38	6	0.23	0.39
Yura	0.33	8	0.17	0.48
Majes	0.28	9	0.15	0.46

[a]Output and operating costs are defined as the values attained when the project reaches full output and total investment is taken as its face value.

[b]R = ranking.

[c]SMP = (A) + (B) + (D) = (A) x (C) + (D).

(D) Balance of Payments Effect (r B/K)		Social Marginal Productivity (SMP)[c]			
r = .5	r = .7	r = o	r = .5	R[b]	r = .7
0.32	0.45	1.09	1.41	1	1.54
0.03	0.04	0.28	0.31	2	0.32
0.03	0.04	0.26	0.29	3	0.30
0.01	0.02	0.26	0.27	4	0.28
0.08	0.11	0.19	0.27	5	0.30
0.01	0.02	0.17	0.18	6	0.19
0.00	0.00	0.17	0.17	7	0.17
0.03	0.04	0.14	0.17	8	0.18
0.04	0.05	0.13	0.17	9	0.18
0.00	0.01	0.15	0.15	10	0.16
-0.03	-0.04	0.16	0.13	11	0.12
-0.01	-0.02	0.13	0.12	12	0.11

Chira-Piura $B_1 = -0.31K - 0.38(1-0.31)K = -0.57K$ (6.42a)

Olmos $B_1 = -0.50K - 0.38(1-0.50)K = -0.69K$ (6.42b)

Jequetepeque $B_1 = -0.43K - 0.38(1-0.43)K = -0.65K$ (6.42c)

Majes $B_1 = -0.14K - 0.38(1-0.14)K = -0.47K$ (6.42d)

Clearly one observes that the imports requirements are larger for the Olmos and Jequetepeque projects. In order to represent B_1 in terms of national income units, we must multiply the values B_1 by the capital recovery factor a. The value of this parameter is the same for all agricultural projects and was determined as being equal to 0.10 according to the useful life of these projects. For the industrial projects we have determined the direct effect of B_1 according to the following relationships:

La Pampilla $B_1 = -0.61K - 0.38(1-0.61)K = -0.76K$ (6.43a)

Steel Plant $B_1 = -0.40K - 0.38(1-0.40)K = -0.63K$ (6.43b)

Fertilizer $B_1 = -0.54K - 0.38(1-0.54)K = -0.71K$ (6.43c)

Yura $B_1 = -0.44K - 0.38(1-0.44)K = -0.65K$ (6.43d)

The La Pampilla project and the Fertilizer Plant have the largest investment import component. Observe that the B_1 effect is larger for industrial projects than for agricultural projects. In order to convert B_1 in units of national income we must multiply B_1 by the capital recovery factor (a). In the industrial projects the capital recovery is different for each project because of substantial differences in the useful life of these projects. For the mining projects we have determined the values of B_1 according to the following relationships:

Cerro Verde $B_1 = - 0.50K - 0.38(1-0.50)K = - 0.69K$ (6.44a)

Michiquillay $B_1 = - 0.24K - 0.38(1-0.24)K = - 0.53K$ (6.44b)

Cajamarquilla $B_1 = - 0.60K - 0.38(1-0.60)K = - 0.75K$ (6.44c)

Ilo $B_1 = - 0.58K - 0.38(1-0.58)K = - 0.74K$ (6.44d)

Taking the twelve projects together we observe that all projects require a high percentage of imports that surpass 50 percent of total investment. The mining projects have the highest import component.

The direct effects of operation on the balance of payments (B_2) are functionally related to X and can be determined according to relation (6.40). The first term on the right hand ($e(1-\overline{mp})X$) determines the net foreign earnings. The parameter (e) defines the proportion of production which is destined for the foreign sector or which substitutes for imports. Their respective values have been extracted from the feasibility studies. Also the imports requirements per unit of production ($\overline{mp}$) have been determined according to the studies. The respective parameters are listed in Table 6.2. The second term of relation (6.40) determines the import requirements per unit of production destined for internal consumption. The coefficient (c) is the proportion of production destined for domestic consumption. The last term in relation (6.40) measures the import requirements of production destined to replace previously consumed commodities. Given the impossibility of identifying the proportion of production which replaces previously consumed commodities we assigned a value of zero to the parameter (g). For the agricultural projects the direct effect of operation B_2 is given by the following relationships:

Chira-Piura $B_2 = 0.29\ (1-0.002)X - (0.71)(0.002)X = 0.288X$ (6.45a)

Olmos $B_2 = 0.27\ (1\ 0.002)X - (0.73)(0.002)X = 0.268X$ (6.45b)

Jequetepeque $B_2 = 0.26\ (1-0.003)X - (0.74)(0.003)X = 0.257X$ (6.45c)

Majes $B_2 = 0.12\ (1-0.002)X - (0.88)(0.002)X = 0.118X$ (6.45d)

With the exception of the Majes project the direct effects on the balance of payments are very similar for the agricultural projects. The effect is the largest for the Chira-Piura project because of the proportionally larger export component in its production. The direct effect B_2 of the industrial projects are given by the following relationships:

La Pampilla $B_2 = 0.385(1-0.013)X - (0.615)(0.013)X = 0.372X$ (6.46a)

Steel Plant $B_2 = 0.385(1-0.02)X - (0.615)(0.02)X = 0.365X$ (6.46b)

Yura $B_2 = 0.10(1-0.02)X - (0.90)(0.02)X = 0.08X$ (6.46c)

Fertilizer $B_2 = 1.00(1-0.02)X = 0.998X$ (6.46d)

With the exception of the Yura cement project the B_2 effect is larger for the industrial projects than the agricultural projects. Observe that the Fertilizer project substitutes 100 percent for current urea imports. For the mining projects we also determined the B_2 effect according to relationship (6.40) as follows:

Cerro Verde $B_2 = 0.95\ (1-0.03)X - (0.05)(0.03)X = 0.92X$ (6.47a)

Michiquillay $B_2 = 1.00\ (1-0.29)X = 0.71X$ (6.47b)

Cajamarquilla $B_2 = 1.00\ (1-0.30)X = 0.70X$ (6.47c)

Ilo $B_2 = 1.00\ (1-0.44)X = 0.56X$ (6.47d)

The production of the mining project with the exception of the Cerro Verde copper mining project, are defined totally by the external market, hence B_2 is determined exclusively by the first term of relation (6.40). When we compare the projects jointly we observe that the mining projects have the largest B_2 effect on the balance of payments because of the nature of their production.

The indirect effect B_3 associated with the operation of the projects has been estimated according to relation (6.41), but we excluded in this computation the second term to the right, because we are assuming that the government will maintain in the long run balance budget. Hence the zero value assigned to the term (f).

Taking that assumption into account the indirect effect is defined by the first term of the relationship (6.41) which is the same for all projects.

$$B_3 = -\ 0.38\ B_2 \tag{6.48}$$

The total effect on the balance of payments is represented for all of the projects in Table 6.10. The results of the values and the ranking generated by the social marginal productivity criterion, Alternative I, is also represented in that table.

With respect to the agricultural projects the social marginal productivity criterion is stable for the different values assigned to the shadow foreign exchange rate (r). Jequetepeque and Olmos projects occupy the first two places. Observe that the balance of payments effect for the Majes project is quite small and the value rB/K is actually negative.

For the industrial projects the ranking suggested by the social marginal productivity criterion is also stable for different values of (r), even though the balance of payments effect is larger for the industrial projects with the exception of the Yura project, which has a negative effect. The La Pampilla and the Steel Plant project occupy the first two places.

In the mining projects Ilo and Cajamarquilla are the most profitable, and they also maintain these positions independent of the different values assigned to (r). On the other hand we must indicate that the hypothesis formulated by Chenery is fulfilled, that is to say that the ranking of the projects within the same sector is determined exclusively by the capital turnover coefficient (V/K), dispensing with the balance of payment effects.

If we take all the projects together we see that the social marginal productivity ranking is only stable for the La Pampilla, Ilo, Steel Plant and Fertilizer projects. When we vary (r) there are significant changes in the position of the remaining projects. For the projects as a whole the ranking suggested by the capital turnover criterion differs from that suggested by the social marginal productivity criterion. This of course is related to the different balance of payments effects as between projects in different sectors.

For Alternative II as related to the application of the social marginal productivity criterion we have proceeded to express the variables K, V and C in their annual equivalent values according to relations 6.33, 6.34 and 6.35. In Table 6.11 we present for the twelve projects the values obtained for the capital turnover coefficients, the cost of operation per unit of investment and the percentage margin of social value over cost. The balance of payments effect since it is related to X and K continue to be defined by relations 6.42 - 6.48, even though we now define them in terms of annuities.

The results of the values and the ranking of the social marginal productivity criterion, Alternative II, are listed in Table 6.11. With respect to the agricultural projects one observes that there has been a variation with respect to the ranking obtained under Alternative I, the first place is now given to the Chira-Piura project. The percentage margin of social value over cost give us an indication of the direction of the change in the ranking with respect to Alternative I. If this percentage margin increases significantly then the benefits have increased more than the costs when we considered the discounting process. It is for this reason that the Jequetepeque project has now been assigned to the second place given that its percentage margin of social value over cost decreases from 0.48 to 0.42.

The ranking of the agricultural projects is stable for different values assigned to the foreign exchange rate. The hypothesis of Chenery

Table 6.11. Social marginal productivity of investment, market wages and alternatives shadow exchange rates (Alternative II)

Project	(A) Capital Turnover (V/K)	R^a	(B) Cost Ratio (C/K)	(C) Value Margin (V-C)/V
La Pampilla	19.04	1	13.49	0.29
Chira-Piura	5.49	2	3.36	0.39
Jequetepeque	4.61	3	2.82	0.39
IloII	2.61	6	0.53	0.80
Steel Plant	3.50	5	1.89	0.46
Fertilizer	2.48	7	1.31	0.47
Olmos	3.87	4	2.28	0.41
Cajamarquilla	1.64	10	0.51	0.69
Michiquillay	1.63	11	0.70	0.57
Cerro VerdeII	1.49	12	0.58	0.61
Yura	2.34	8	1.20	0.49
Majes	1.84	9	0.94	0.49

[a]R = ranking.

[b]SMP = (A) + (B) + (D) = (A) x (C) + (D).

(D) Balance of Payments Effect (r B/K)		Social Marginal Productivity[b] (SMP)			
r = .5	r = .7	r = 0	r = .5	R[a]	r = .7
2.28	3.19	5.55	7.83	1	8.74
0.46	0.65	2.13	2.59	2	2.78
0.34	0.48	1.79	2.13	3	2.27
0.48	0.68	2.08	2.56	4	2.76
0.36	0.50	1.61	1.97	5	2.11
0.72	1.01	1.17	1.89	6	2.18
0.29	0.41	1.59	1.88	7	2.00
0.33	0.46	1.13	1.46	8	1.59
0.38	0.54	0.93	1.32	9	1.47
0.39	0.54	0.91	1.30	10	1.45
0.01	0.01	1.14	1.15	11	1.15
0.04	0.06	0.90	0.94	12	0.96

that the capital turnover ratio determines the same ranking within the same sector as the social marginal productivity criterion is hence once again confirmed.

In the industrial and mining projects we observe a similar ranking as that obtained for Alternative I and also Chenery hypothesis again is confirmed in this particular instance. If we take the twelve projects together we observe that the social marginal productivity ranking is different with respect to Alternative I. Only the first four projects maintain their positions when one varies the foreign exchange rate.

The ranking suggested by the capital turnover criterion is diametrically different from that given by the social marginal productivity criterion. This because the balance of payments effect is different for the different sectors. With the exception of the Majes project the performance of the agricultural projects improve under this second alternative.

In general Alternative II determines a ranking different from that obtained under Alternative I, but the displacements are with respect to changes of positions of projects within the same sector, with exception of the Chira-Piura irrigation and the Ilo project.

Finally in Alternative III we have included the shadow price for labor in the determination of the social marginal productivity criterion. As one can appreciate from Table 6.12 the agricultural projects improve significantly their percentage margin of social value over cost, whereas the industrial and mining projects maintain the same values of Alternative

Table 6.12. Social marginal productivity of investment, shadow wage at 60 percent of market wage and alternative shadow exchange rates (Alternative III)

Project	(A) Capital Turnover (V/K)	R^a	(B) Cost Ratio (C/K)	(C) Value Margin (V-C/V)
La Pampilla	19.10	1	13.53	0.29
Chira-Piura	5.57	2	2.81	0.50
Jequetepeque	4.72	3	2.47	0.48
IloII	2.62	6	0.53	0.80
Olmos	3.93	4	1.91	0.51
Steel Plant	3.52	5	1.90	0.46
Fertilizer	2.48	7	1.31	0.47
Cajamarquilla	1.64	10	0.51	0.69
Michiquillay	1.63	11	0.70	0.57
Cerro VerdeII	1.49	12	0.58	0.61
Yura	2.34	8	1.20	0.49
Majes	1.85	9	0.80	0.57

[a] R = ranking.

[b] SMP = (A) + (B) + (D) = (A) x (C) + (D).

Balance of Payments Effect (r B/K)		Social Marginal Productivity[b] (SMP)			
r = .5	r = .7	r = o	r = .5	R[a]	r = .7
2.28	3.19	5.57	7.85	1	8.76
0.47	6.66	2.76	3.23	2	3.42
0.35	0.49	2.25	2.60	3	2.70
0.47	0.65	2.09	2.56	4	2.74
0.30	0.42	2.02	2.32	5	2.44
0.36	0.50	1.62	1.98	6	2.12
0.72	1.01	1.17	1.89	7	2.18
0.33	0.46	1.13	1.46	8	1.59
0.39	0.54	0.93	1.32	9	1.47
0.39	0.54	0.91	1.30	10	1.45
0.01	0.01	1.14	1.15	11	1.15
0.05	0.07	1.05	1.10	12	1.12

II. This result is the product of the intensity of unskilled labor utilized for the agricultural projects during the period of construction.

The results of the values and ranking of the social marginal productivity criterion, Alternative III, are listed in Table 6.12. The ranking of the agricultural projects is similar as that obtained under Alternative II, even though each project increases its profitability indexes significantly because of the shadow wage effect. The mining and industrial projects also maintain the same ranking as obtained under Alternative II, but their profitability indexes as measured by the social marginal productivity criterion does not change significantly. If we take all the projects together we observe that the social marginal productivity ranking is virtually stable with respect to Alternative II, except with respect to the Olmos project which now displaces the Steel plant project to the sixth position. The first four positions are occupied as in the former alternative by the La Pampilla, Chira-Piura, Jequetepeque and Ilo projects respectively.

C. Semi Input-Output Method

The conceptual basis of the semi input-output method, was developed in detail in Chapter IV. In this section we will proceed to evaluate the twelve selected projects and to determine the advantages and limitations of this particular method. In principle the semi input-output method is an attempt to incorporate explicitly in the evaluation of projects the intersectoral benefits associated with an initial investment.

For the application of the above mentioned method we have selected the input-output table of the Peruvian economy for the year 1968 [40].

This table was prepared by the National Planning Institute and is actualized from one year to the next, in order to serve as an additional support element in the preparation of macroeconomic projections. One of the advantages of this table is its level of sectoral disaggregation. In its original version we have 74 sectors, 34 sectors and 9 sectors, with detailed commentaries as to the procedures followed in aggregating these sectors. For the purposes of this evaluation we have considered the 1968 input-output table, actualized in terms of 1974 prices, and aggregated for 9 sectors [35]. In Table 6.13 and 6.14 we present the coefficient matrix and its corresponding inverse.

For the application of the semi input-output method we start with the initial technical coefficient matrix without differentiating between national and international sectors. This because the sectors generally are strongly related to the external sectors. Because of this we will estimate the intersectoral effect of the initial investment and once we have obtained the induced production, these will be adjusted according to the average propensity to import for each sector. If we follow the methodology developed in Chapter IV the intersectoral effect of an investment project is given by the following relation:

$$X_n = (I - A_{nn})^{-1} \cdot Y_n \qquad n = 1, \ldots, 9 \tag{6.49}$$

where:

X_n = vector of sectoral gross output,

Y_n = initial production,

A_{nn} = technical coefficients, and,

$(I-A_{nn})^{-1}$ = inverse matrix.

Table 6.13. Input coeficients for the semi-input-output application[a]

Sector	Sector	(1)	(2)	(3)	(4)
Agriculture	(1)	0.1301	0.0	0.0001	0.0
Fisheries	(2)	0.0	0.0	0.0	0.0
Mining	(3)	0.0017	0.0	0.2218	0.0
Power	(4)	0.0	0.0	0.0127	0.0
Industry Consumption Goods	(5)	0.0469	0.0468	0.0006	0.0051
Industry Intermediate Goods	(6)	0.0271	0.0561	0.0771	0.0919
Industry Capital Goods	(7)	0.0009	0.0593	0.0833	0.0658
Construction	(8)	0.0	0.0	0.0	0.0
Services	(9)	0.33649	0.3116	0.065	0.0001
Total Inputs		0.54319	0.4738	0.4606	0.1629
(Imports)		0.095	0.0	0.0516	0.0
Value Added		0.45681	0.5262	0.5394	0.8371

[a]Peru Input-Output Table 1974 [36].

(5)	(6)	(7)	(8)	(9)
0.1462	0.0152	0.0	0.0	0.0
0.0026	0.0825	0.0	0.0	0.0
0.0006	0.1586	0.0	0.0018	0.0
0.0053	0.0093	0.0055	0.0	0.007
0.1468	0.0252	0.012	0.0127	0.0204
0.1235	0.1851	0.2147	0.3126	0.0321
0.023	0.0314	0.1925	0.0435	0.0244
0.0	0.0	0.0	0.0	0.0144
0.286	0.1439	0.3362	0.0	0.166
0.734	0.6512	0.7609	0.3706	0.2613
0.1293	0.2435	0.5351	0.0	0.0
0.266	0.3488	0.2391	0.6294	0.7387

Table 6.14. Inverse matrix $(A-I)^{-1}$ for the semi-input-output application

Sector	Sector	(1)	(2)	(3)	(4)
Agriculture	(1)	1.16446	0.01456	0.00577	0.00502
Fisheries	(2)	0.00711	1.01102	0.01491	0.01220
Mining	(3)	0.01967	0.02684	1.32179	0.03006
Power	(4)	0.00528	0.00581	0.02084	1.00289
Industry Consumtion Goods	(5)	0.07996	0.07298	0.01469	0.01450
Industry Intermediate Goods	(6)	0.08369	0.13121	0.18031	0.14737
Industry Capital Goods	(7)	0.02604	0.09928	0.15302	0.09425
Construction	(8)	0.00600	0.00540	0.00238	0.00088
Services	(9)	0.52637	0.47339	0.20875	0.07744

(5)	(6)	(7)	(8)	(9)
0.20706	0.03257	0.01468	0.01346	0.00697
0.02306	0.10858	0.03190	0.03565	0.00627
0.05062	0.26798	0.07859	0.09021	0.01534
0.01373	0.01902	0.01628	0.00686	0.01005
1.20690	0.05700	0.04722	0.03522	0.03370
0.24151	1.31430	0.38522	0.43100	0.07489
0.06991	0.10108	1.28578	0.08869	0.04522
0.00661	0.00412	0.00712	1.00169	0.01423
0.57984	0.36167	0.62495	0.14798	1.24810

Subsequently we will assume that the induced productions will immediately achieve full production. We also assume that the period of production in the induced sectors is the same as that in the autonomous sector. In this form the present value of sectoral production can be summarized by the following expression:

$$B_n = \sum_{t=1}^{T} \frac{X_{nt}}{(1+i)^t} \qquad t = 1, \ldots, T \tag{6.50}$$

where:

B_n = present value of annual gross production, sector n,

X_{nt} = annual gross production of sector n, year t,

i = rate of discount.

In order to obtain representative figures for total benefits we must correct the present value of gross sectoral production (B_n) using the respective value added coefficients. This adjustment is effected by utilizing the following relationship:

$$B = \sum_{n=1}^{9} Va_n \cdot B_n \tag{6.51}$$

where each additional term is defined as:

B = total benefit, and,

Va_n = value added coefficient, sector n.

With respect to the induced investments we are assuming that all the investment costs are incurred given a similar period of construction for all investment projects. Also given the statistical limitations with respect to investments by sectors, we will use the capital-output ratio for the whole economy and assuming that this is applicable to each sector separately. Under these assumptions the total costs of investment are then given by the following relationships:

$$C_n = R \cdot X_n \tag{6.52}$$

$$C = \sum_{t=1}^{T} \frac{Ca_t}{(1+i)^t} + \sum_{n=1}^{8} \sum_{t=1}^{T} \frac{Cn_t}{(1+i)^t} \tag{6.53}$$

where:

C = total investment,

C_n = sectoral investment,

C_a = autonomous investment,

X_n = sectoral gross output, and

R = global capital-output ratio.

The application of this variant of the semi input-output method and the calculation of the benefit-cost ratio will be done for each project separately and we will then compare the results obtained with the methods previously discussed.

The increases in sectoral production, as determined by relationship 6.49 are listed in Table 6.15. The gross production of the autonomous sector refers to the annual average production of the projects stipulated in the feasibility studies. Once we have obtained the sectoral production we then proceeded to determine the present value, taking as the economic horizon the useful life of the autonomous project. That is to say, if the autonomous project has an economic life equal to 50 years then the same figure is applied also to the investment projects associated with induced production. Once we have obtained the present values utilizing a 10 percent discount rate, we then proceeded to calculate the value added of the autonomous project and that of the induced production according to the technical coefficients which have been listed in Table 6.13. The representative figure of benefits, given by relationship 6.51 is determined by subtracting from the value added figures the necessary imports required for each sector. The sum of the sectoral benefits determines the total benefit of the project.

With respect to costs we have assumed for all projects the same period of construction as that of the autonomous project. That is if the autonomous project requires five years of construction, then the same period is assumed to hold for the induced sectoral costs. We assume that the investments are made in equal annual installments. The sectoral investments have been determined by utilizing the global capital-output ratio previously defined and determined as being equal to 2.2. The sum of these sectoral investments determines the total cost of the project.

The results obtained in terms of the benefit-cost ratio for each project separately and considering the intersectoral effects are listed in Table 6.15. The values and ranking obtained are compared with respect to Alternative I of Marglin, because in both cases we utilize market prices for the quantization of costs and benefits.

Table 6.15. Benefit-cost ratio of the selected projects derived from the semi-input-output method

Project (million soles) / Sector	La Pampilla Output Effect	La Pampilla Capital Requirement	Jequetepeque Output Effect	Jequetepeque Capital Requirement
Agriculture	553.5	1217.7	3639.3[a]	5922.0[b]
Fisheries	1844.8	4058.6	25.9	57.0
Mining	4553.3	10017.3	71.6	157.5
Power	323.1	710.8	19.2	42.2
Industry Consumption Goods	968.4	2130.5	291.0	640.2
Industry Intermediate Goods	16990.8[a]	5633.9[b]	304.6	670.1
Industry Capital Goods	1717.5	3778.5	94.8	208.6
Construction	70.1	154.2	21.8	48.0
Services	6145.0	13519.0	1915.6	4214.3
Net Benefit	84950.8	-	21385.0	-
Net Cost	-	34171.7	-	9478.1
Benefit Cost Ratio[c]:				
Project Alone	6.14		2.17	
Global	2.49		2.25	

[a]Project annual gross production.

[b]Project total investment.

[c]Social rate of discount = 10%.

Chira-Piura		Olmos		Steel Plant	
Output Effect	Capital Requirement	Output Effect	Capital Requirement	Output Effect	Capital Requirement
4422.8[a]	11780.6[b]	4691.1[a]	11396.4[b]	1165.9	2565.0
31.4	69.1	33.4	73.5	3886.1	8549.4
87.0	191.4	92.3	203.1	9591.4	21101.1
23.3	51.3	24.8	54.6	680.6	1497.3
353.6	777.9	375.1	825.2	2040.0	4488.0
370.1	814.2	392.6	863.7	35791.1[a]	65907.7[b]
111.2	244.6	122.2	268.8	3617.9	7959.4
26.5	58.3	28.1	61.8	147.6	324.7
2328.0	5121.6	2469.2	5432.2	12944.4	28477.7
26093.7	-	22832.5	-	165618.1	-
-	15143.4	-	13920.9	-	111639.1
1.33		1.34		1.07	
1.72		1.64		1.48	

Table 6.15. Continued

Project (million soles) Sector	IloII Output Effect	IloII Capital Requirement	Fertilizer Output Effect	Fertilizer Capital Requirement
Agriculture	13.6	29.9	46.3	101.9
Fisheries	35.2	77.4	154.5	339.9
Mining	2362.5[a]	5891.9[b]	381.3	838.9
Power	49.2	108.2	27.1	59.6
Industry Consumption Goods	34.7	76.3	81.1	178.4
Industry Intermediate Goods	426.0	937.2	1423.0[a]	3634.8[b]
Industry Capital Goods	361.5	795.3	143.8	316.4
Construction	5.6	12.3	5.9	13.0
Services	493.2	1085.0	514.6	1132.1
Net Benefit	11041.4	-	6991.1	-
Net Cost	-	7472.3	-	5741.7
Benefit Cost Ratio[c]				
Project Alone	1.58		0.75	
Global	1.48		1.22	

Majes		Michiquillay		Yura	
Output Effect	Capital Requirement	Output Effect	Capital Requirement	Output Effect	Capital Requirement
4114.3[a]	14757.6[b]	64.3	141.5	16.1	35.4
29.3	64.5	106.2	365.6	53.8	118.4
80.9	178.0	11144.0[a]	35752.5[b]	132.8	292.2
21.7	47.7	232.3	511.1	9.4	20.7
329.0	723.8	163.7	360.1	28.2	62.0
344.3	757.5	2009.3	4420.5	495.4[a]	1467.7[b]
107.1	235.6	1705.2	3751.4	50.1	110.2
24.7	54.3	26.5	58.3	2.0	4.4
2165.6	4764.3	2326.4	5118.1	179.2	394.2
18165.6	-	40862.4	-	2212.6	-
-	15009.8	-	30639.4	-	2076.7
0.84		1.06		0.61	
1.21		1.11		1.06	

Table 6.15. Continued

Sector / Project (million soles)	Cajamarquilla Output Effect	Cajamarquilla Capital Requirement	Cerro Verde II Output Effect	Cerro Verde II Capital Requirement
Agriculture	17.3	38.1	125.4	275.9
Fisheries	44.8	98.6	323.9	712.6
Mining	3002.8[a]	11504.9[b]	21721.0[a]	90435.7[b]
Power	62.6	137.7	452.8	996.2
Industry Consumption Goods	44.1	97.0	319.2	702.2
Industry Intermediate Goods	541.4	1191.1	3916.4	8616.1
Industry Capital Goods	459.5	1010.9	3323.7	7312.1
Construction	7.1	15.6	51.7	113.7
Services	626.8	1379.0	4534.4	9975.7
Net Benefit	11940.9	-	86088.8	-
Net Cost	-	12261.3	-	94418.5
Benefit Cost Ratio[c]:				
Project Alone	0.87		0.81	
Global	0.97		0.91	

With respect to agricultural projects the overall benefit-cost ratio selected the Jequetepeque project as being the most profitable, whereas the Majes irrigation project again occupies last place. All projects obtain a benefit-cost ratio larger than unity. The same ranking is obtained for the agricultural projects when one does not incorporate the intersectoral effects. However, the Majes project obtains a benefit-cost ratio of 0.84 which is close to that obtained by the Marglin's method.

In the industrial projects the overall benefit-cost ratio selects the La Pampilla project and the Steel Plant project as the most profitable. All projects now obtain a benefit-cost ratio larger than unity. If we take the benefit-cost ratio without considering the intersectoral effects we obtain a similar ranking, but the fertilizer project and the Yura cement project now obtain a benefit-cost ratio less than unity. The ranking of the industrial projects obtained with the semi input-output method is identical to that obtained for the Alternative utilizing Marglin's method. With respect to the mining projects, the overall benefit-cost ratio indicates that the Ilo and Michiquillay refineries are the most profitable. The Cajamarquilla and Cerro Verde projects now obtain a benefit-cost ratio less than unity. Observe that the benefit-cost ratio of Cerro Verde (0.91) is very similar to that obtained by Marglin under Alternative I (0.94).

If we take the twelve projects together, then the La Pampilla, Jequetepeque, Chira-Piura, Olmos and the Steel Plant occupy the first five positions of the ranking. If we compare this result with that obtained under Alternative I as suggested by Marglin we observe that the same projects with the exception of Jequetepeque obtain those same five positions. One should observe therefore that the indexes obtained by both methods are quite similar.

In general we can therefore state that the results obtained by this method are highly correlated with that of the value of production of the autonomous project. That is to say when the annual production of the project is greater the greater will be the intersectoral effects. Nevertheless the final figure of annual benefits is also influenced by the period of construction and the period of operation of the autonomous project.

With respect to the agricultural projects we observe that the Olmos project obtains the largest sectoral production effect because of its largest annual production, but the Chira-Piura project nevertheless generates the largest total annual benefits because of its largest period of production and shortest period of construction.

If we do not take into account a discounting process, then the projects with a larger annual production and larger period of construction will be significantly affected, because with this method the induced investments are also basically determined the levels of sectoral production.

The same phenomenom can be observed in the industrial and mining sectors. That is to say the largest final benefits are not necessarily given by those projects which have the largest annual production. However, for a similar sector the homogeneity of the periods of production and operation guarantee that the project with the largest annual production will also be the most favored. With respect to intersectoral effects the service sector, mining and intermediate goods generate the larger total amount of benefits because of their large technical coefficients.

On the other hand we must indicate that the size of the benefits and costs depend on the degree of disaggregation of the initial input-output matrix, even though the benefit-cost ratio can be expected to be stable because of the assumption of fixed technical coefficients. In conclusion we must mention that the semi input-output method allows us to discriminate between profitable and nonprofitable projects, generating thereby an acceptable ranking given the relatively small amount of information which is necessary to implement this method. If we compare the results of this method with that of Alternative I as suggested by Marglin we can see that the values of the benefit-cost ratio are very similar and indeed give almost the same ranking for the projects within a given sector.

D. The Comparative Ranking of Selected Projects

In this section we proceed to make the comparisons between the different investment criteria and the resulting rankings of these, both at the sectoral level as well as for the twelve projects taken together. When we make these comparisons we will explain in each case the reasons which cause the displacements in sectoral ranks and with respect to the total ranking, as related to the utilization of one or the other method of evaluation.

First we will analyze the results obtained with the three alternatives as suggested by Marglin, comparing for each alternative the rankings yielded by the profitability indexes such as net present value, benefit-cost ratio and the internal rate of return. Subsequently we will compare the same method of Marglin as between these three alternatives, so as to establish how the assumptions of each one influences in the sectoral ranking of the projects. The same type of analysis we will apply with respect to the method proposed by Little and Mirrlees, called Alternative IV and the social marginal productivity method proposed by Chenery and the semi input-output method.

The comparison between criteria for the global ranking will be done on the basis of Alternative II and III of Marglin, subsequently called MII and MIII and Alternative III of Chenery, subsequently called SMPIII. We have selected these three variants given that they contain the assumptions and basic methodological element for a social benefit-cost analysis of the project. Consequently all these alternatives do include a shadow price for labor and foreign exchange. With Alternative MIII we also include different weighting factors for consumption according to the different economic groups which participate in benefits from the project.

We eliminated Alternative I as proposed by Marglin because the quantification of costs and benefits in this method are based on market prices. We also eliminated Alternative IV as proposed by Little and Mirrlees because that method is equivalent to the alternative by Marglin except that the costs of labor in both the construction and operation periods are expressed in terms of consumption rather than in terms of investment as with the Marglin method.

Also Alternatives I and II of Chenery have been excluded for purposes of this global comparison because the first alternative does not take into account the discounting process and the second alternative is based on market prices.

Similarly we have excluded the semi input-output method because of the statistical limitations which force us to apply rather naive application of this model based on market prices and a global capital-output ratio for all sectors.

On the other hand while the comparative sectoral analysis will be based on the consideration of the separate indexes of profitability, we will for the global analysis only consider the data or results generated by the utilization of the benefit-cost ratio.

This selection does not signify our preference of the benefit-cost ratio over the net present value or the internal rate of return in the evaluation of projects, because each index of profitability gives us an additional element in the preparation of a program of investments. In principle for each project which has been evaluated separately we will obtain a positive benefit-cost ratio, and hence we also would expect to obtain a positive net present value or positive internal rate of return. But when we make comparisons between projects that are so heterogenous in their structure as well as in the amount of investments and benefits expected as between different projects between different sectors of production the ranking based upon net present value will obviously favor these projects that are somewhat larger in scale.

An example that supports this argument can be found in such projects which maintain a certain proportionality between costs and benefits so that the net present value will be the larger for the project that involves more investment. This argument can also be confirmed with respect to the Cerro Verde project, which when it was evaluated commercially will result in the last position with actually a negative net present value. But when we considered a shadow wage rate and a shadow price for foreign exchange this project then occupies the third position in the net present value ranking. Nevertheless if we evaluate this project with respect to its benefit-cost ratio it continues to maintain one of the last positions in the global ranking.

With respect to the results obtained with the internal rate of return we can forward a similar argument, because it is possible to obtain a rate of return equal to 100 percent with a small investment and a 15 percent return on a large investment. In any case the internal rate of return allows us to compare the indexes obtained with the grant equivalent or with the social rate of discount so as to be able to answer questions related to the cost of capital involved.

Finally the last argument which favors the utilization of the benefit-cost ratio with the social marginal productivity criterion is the similarity of coefficients obtained. In both cases the numerator represents benefits and the denominator the initial investment costs which makes the comparison more or less equivalent.

1. Sectoral ranking

For the irrigation projects we observe that the ranking of Alternative I (Tables 6.3 and 6.4) based on market prices is identical for the net present value and the benefit-cost ratio, putting the Chira-Piura project and the Olmos project in the first two positions whereas the Majes irrigation project occupies the last and fourth position. The ranking furnished by the internal rate of return (Table 6.5) causes an interchange between the Chira-Piura and the Olmos project, because of the larger construction period of the last project. With the exception of the Majes project, the irrigation projects obtain an index of commercial profitability which is positive.

When we include shadow prices for labor and foreign exchange as in Alternative II (Tables 6.3, 6.4 and 6.5) the three indexes of profitability coincide in the ranking of the four mentioned irrigation projects. This result is the same as that obtained for the net present value and the benefit-cost ratio of Alternative I. In this alternative all the projects of irrigation obtain a positive social profitability. When we include weighting factors as related to consumption in Alternative III, the ranking furnished by the net present value and the benefit-cost ratio are identical, but the Jequetepeque project displaces to third position the Olmos irrigation project, which is affected because of its larger investment requirements and because of the weighting of in favor of government consumption. In this alternative with exception of the Majes project all irrigation projects again obtain a positive social profitability. In summary the ranking obtained by the net present value and benefit-cost ratio are equivalent in all alternatives. On the other hand, with the ranking as generated by the internal rate of return we do observe differences between Alternative II and Alternative III.

With reference to the industrial projects we observe in the same Tables 6.3, 6.4 and 6.5 that the ranking under Alternative I is identical for the benefit-cost ratio and the internal rate of return, placing the La Pampilla oil refinery and the Steel Plant in the first two positions, whereas the Fertilizer project and the Yura cement project now occupy the two lowest positions. On the other hand for the net present value ranking the Chimbote Steel plant will be selected as the most profitable project, but this is the result of the larger value of production of the Steel plant relative to the La Pampilla project. Again all industrial projects are profitable from a commercial point of view.

When we include a shadow wage rate and a shadow price of foreign exchange as in Alternative II (Tables 6.3 - 6.5), each index of profitability give us a different ranking. Nevertheless both the net present value and the benefit-cost ratio ranking do give us the same results as under Alternative I. On the other hand the ranking furnished by the internal rate of return criterion places in second position the Fertilizer project, which is due to the premium assigned to foreign exchange. All projects again are profitable from a social point of view.

When we incorporate weighting factors of consumption as under Alternative III we observe in Tables 6.3 - 6.5 that the indexes of social profitability generate a ranking which is different but comparable with that of Alternative II. In summary the ranking provided by net present value selects the Steel Plant and the La Pampilla project as being the most profitable, and maintaining a similar ranking for all three alternatives. The benefit-cost ratio also is similar for the three alternatives, but interchanges places between La Pampilla oil refinery and the Steel plant. The internal rate of return will select the La Pampilla project as the most profitable project and at the same time displaces the Steel plant to a third position. In all the alternatives and indexes of profitability utilized, the Yura cement project obtains the last enforced position.

With respect to the mining projects we observe in the same Tables 6.3 - 6.5, that the indexes of profitability of Alternative I yields the same ranking, placing Ilo and Cajamarquilla projects in the first two positions and the Cerro Verde project in the last position with actually a negative profitability. When we incorporate shadow prices for labor and foreign exchange as under Alternative II each index of profitability yields a different ranking, as can be seen in Tables 6.3 - 6.5. With respect to the net present value ranking, the Cerro Verde and Michiquillay project now occupy the first two positions because of the premium given to foreign exchange and because of the amount of annual production which are significantly larger than the Ilo and Cajamarquilla projects.

On the other hand when we consider the initial investment in the denominator that is the benefit-cost ratio, the Ilo project maintains its first position and Cerro Verde is now displaced to the last position. The ranking as related to the internal rate of return is similar to that obtained as under Alternative I. All mining projects are profitable from a social point of view under this alternative.

If we incorporate weighting factors for consumption as in Alternative III, the ranking generated for each index of profitability continues to be different, as can be seen in Tables 6.3 - 6.5. Nevertheless, both the net present value, the benefit-cost ratio and the internal rate of return give us similar results to that obtained as under Alternative II. Again all mining projects prove to be socially profitable under this alternative.

On the other hand we have the method proposed by Little and Mirrlees as under Alternative IV, which we have already identified as being equivalent to Alternative II of Marglin, because the assumptions and parameters utilized are the same except that under Alternative IV the numeraire is in terms of consumption. The ranking obtained for the net present value, the benefit-cost ratio and the internal rate of return (Tables 6.3 - 6.5) is exactly the same as that obtained under Alternative II of Marglin for the mining and industrial projects. In the irrigation projects the net present value and the benefit-cost ratio also yield similar results. Nevertheless with respect to the ranking as related to the internal rate of return, the Jequetepeque project now occupies the second place. This displacement is produced because of the longer construction period of the Olmos project. That is because when we express labor in terms of consumption and divide the annual capital and consumption flows by the price of investment, the resulting present values are reduced to a proportionally greater extent for the costs of the Jequetepeque project than for the Olmos project. In this particular alternative all twelve investment projects are socially profitable.

When we utilize the social marginal productivity criterion we only consider that alternative of each variant of analysis which assumes a premium of 0.5 for foreign exchange. That is we do not restate the results obtained for the social marginal productivity criterion which assume that $r = 0$ or alternately where $r = 0.7$. In alternative I of the social marginal productivity criterion (Table 6.10), we consider the total investment as an absolute figure without considering a discounting process. The ranking of this alternative places the Jequetepeque and Olmos project in the first two positions, and assigns last place to the Majes project. All irrigation projects obtain a social marginal productivity larger than the social rate of discount, which implies that all are socially profitable.

In Alternative II (Table 6.11) we do include a discount factor with respect to the initial investment, costs and benefits and we observe that the Chira-Piura project now pushes the Jequetepeque project to a second position. This displacement is due to the larger annual benefits of the Chira-Piura irrigation project, both in absolute amounts as well as to the period of reference through which they are to be received.

Alternative III of the social marginal productivity criterion also includes a shadow wage rate but this inclusion does not influence the ranking of the irrigation projects as obtained under Alternative II.

When we compare the results of Alternative III utilizing the social marginal productivity criterion and the method proposed by Marglin we observe that the ranking of the net present value and the benefit-cost ratio are equivalent to those obtained by the social marginal productivity criterion. Nevertheless with Alternative II as proposed by Marglin, the Olmos project occupies second position, which is placed in third position by the social marginal productivity criterion. This difference is due to the fact that the social marginal productivity criterion under Alternative II does not include a shadow wage rate which affects the Olmos project relative to the Jequetepeque project.

In the industrial projects the social marginal productivity ranking for the three alternatives are identical (Tables 6.10 - 6.12), placing the La Pampilla and the Steel plant project in the first two positions, and the Yura cement plant in fourth position. This result is similar as that furnished by the benefit-cost ratio on all possible alternatives of the method proposed by Marglin. But when we utilize the net present value ranking we do have an interchange between the first and second position between the steel plant and the La Pampilla refinery.

On the other hand the social marginal productivity ranking of the mining projects are identical for the three alternatives (Tables 6.10 - 6.12), placing the Ilo project, Cajamarquilla and Michiquillay project in the first three positions and the Cerro Verde project in last position. This result is similar to that obtained with the internal rate of return criterion and all the alternatives considered under Marglin's method, but when we utilize the benefit-cost ratio criterion we observe an interchange of the Michiquillay and Cajamarquilla projects. The results obtained with the net present value criterion are very different from that with the social marginal productivity criterion which as previously indicated is due to differences in monetary income, that is to say the projects which have larger annual benefits automatically obtains larger net present values.

The irrigation projects as well as industrial and mining project prove to be socially profitable under all three alternatives suggested by the social marginal productivity criterion.

With respect to the ranking furnished by the semi input-output method (Table 6.15), the ranking of the irrigation projects differs from that obtained by the previous methods, because it places the Jequetepeque project in first position. Also similarly to the previous methods the Majes project is placed last. The ranking of industrial projects is similar to that obtained by the social marginal productivity criterion, but for the mining projects we do observe an interchange of the positions between the Michiquillay and the Cajamarquilla project. But the Cerro Verde project again maintains its fourth and last position. According to the benefit-cost ratio obtained by the semi input-output method all projects prove to be profitable.

2. Global ranking

For the purposes of a comparative analysis between the ranking generated by Alternatives II and III of Marglin, subsequently called MII and MIII and Alternative III of Chenery, subsequently called SMPIII, we will describe and justify the locations of the ranking and the displacements which occur when making a comparison between one alternative and another. We must emphasize that we are considering the ranking furnished by the utilization of the benefit-cost ratio and for the marginal productivity criterion we are considering the variant which assigns a premium of 50 percent to the utilization of foreign exchange. First we must compare the results between alternatives MII and SMPIII and subsequently include the results of Alternative MIII.

The La Pampilla oil refinery is considered to be the most profitable project under the three alternatives. This result is due to the relative small amount of investment required relative to the annual value of production generated. This project has been favored by the internal price policy which has increased fivefold the prices of petroleum derivatives in the last two years. In the other hand the input for maintenance and operation are of national origin and can be provided by the same enterprise that operates the project. That is to say, the cost per barrel of crude oil is calculated according to the cost of exploitation and not according to the international price.

For the second position within the global ranking alternative MII selects the Ilo copper refinery whereas the Alternative SMPIII selects the Chira-Piura irrigation project. Both projects have a similar proportionality between the initial investment and annual benefits generated, nevertheless with alternative MII the Ilo project is favored because of the premium assigned to foreign exchange which is sufficiently large so as to counter the effect assigned to the unskilled labor imputed to the Chira-Piura project. But the foreign exchange premium as calculated under Alternative SMPIII is not sufficiently large to keep the Ilo project in the second position of the ranking. That is to say in Alternative MII the foreign exchange premium is imputed to all the annual production whereas in Alternative SMPIII only to 56 percent of the annual production is given by relationship 6.47d. On the other hand the Chira-Piura project has a similar balance of payments effect in both alternatives.

For the fourth and fifth position within the global ranking, the alternative MII selects the Olmos irrigation project and the Jequetepeque project respectively. This is due to the fact that under Alternative MII the construction and operating foreign exchange costs are larger for the Jequetepeque irrigation, whereas in Alternative SMPIII this difference tends to disappear as can be seen in Table 6.2 and relationships 6.42 and 6.45. We already indicated that with respect to irrigation projects the Chira-Piura project is the most profitable.

For the sixth and seventh position of the global ranking both alternatives coincide to select the Steel Plant and the Fertilizer project respectively.

On the other hand, the eighth and ninth positions are undecided between the Michiquillay and Cajamarquilla project. According to the

Alternative MII the Michiquillay project is more profitable than the Camarquilla refinery. This is because in Alternative MII the construction foreign component is greater in the Cajamarquilla project, nevertheless in Alternative SMPIII the direct investment on the balance of payment is still greater for the Cajamarquilla project but the difference is less impressive.

For the tenth position both alternatives coincide to select the Cerro Verde project.

Finally the eleventh and twelfth positions of the global ranking is undecided between the Majes irrigation project and the Yura cement plant. The Alternative MII selects the Majes project because in this alternative the Yura project obtains a negative net foreign exchange effect, whereas in Alternative SMPIII this project obtains a positive balance of payments effect.

With respect to the values and ranking of Alternative MIII we observe in Table 6.4 that only the irrigation projects have decreased their benefit-cost ratio with respect to the values obtained under Alternative MII. This decrease is caused by a disproportionate increase in investment costs with respect to the benefits. That is to say while the capital expenditures and the premium to be paid for foreign exchange have increased by 90 percent, the net benefits have increased only by 17 percent due to the weight given to consumption by the public sector and by farmers respectively. We must observe that this outcome is the result of the initial assumption about the marginal propensities to consume and to invest by the economic groups participating in the investment project. That is to say we assumed that the public sector saves a greater share of its income relative to farmers.

Taking these assumptions into consideration we observe that the mining and industrial projects have improved slightly their benefit-cost ratio and ranking but keeping among them the order obtained under Alternative MII. On the other hand the irrigation projects have decreased significantly their benefit-cost ratio, but they also maintain among them the ranking obtained under Alternative MII. Nevertheless they have been displaced to the second half of the global ranking. Under this alternative all projects except the Majes irrigation are considered socially profitable.

E. Partial Evaluation Criteria and National Objectives

The evaluation and ranking of the twelve selected projects have been done according to the indexes of profitability suggested by the application of different methodologies of evaluation. Nevertheless it is common practice in the social benefit-cost evaluation of projects to relate the performance of a given investment to one or more specific objectives such as production, employment and the balance of payments.

In this study we have not tried to obtain a ranking according to the contribution of the project to these national objectives, because the nature of the sectoral projects determine by their performance within the global ranking these comparative advantages in terms of production, employment and foreign exchange savings.

By simple inspection of Table 6.2 we can appreciate that the agricultural projects which contribute to the generation of employment, whereas the mining projects are specifically conceived to contribute to the generation of foreign exchange. If we were to take a ranking which would take into account only one or the other partial aspect then logically we would arrive at a ranking quite different when we consider all of these aspects simultaneously. Nevertheless we must emphasize that the methods utilized here can be used to demonstrate the effects on partial objectives.

The objective of increasing national income can be measured by the net present value, the benefit-cost ratio, the social marginal productivity criterion, the semi input-output method or whatever combination of variables which permit us to construct the output-investment ratio. On the other hand the foreign exchange objective can be represented by the component rB/K of the social marginal productivity method, the output in the foreign exchange-investment ratio or whatever combination of variables that reflect the construction of a project as related to the generation of foreign exchange.

The objective of employment generation can be measured by the employment-output ratio or/and the employment-investment ratio or whatever combination of variables that reflect wages and salaries associated with production or capital expenditures. On the other hand we must observe that both the statistical information as well as the computation of profitability indexes have been done in such form as to be able to compute these partial contributions of these projects.

VII. SUMMARY AND CONCLUSIONS

The objective pursued throughout this thesis has been to formulate investment evaluation criteria which allows for the selection and preparation of a public investment program which is consistent with the national development plan both at the national, regional as well as sectoral level.

Initially we analyze the theoretical basis for the traditional principal methods of evaluation which are still frequently used as the instrument of analysis in feasibility studies and financial-economic reports submitted to public entities.

Given the limitations of these methods we present and analyze the conceptual basis of social benefit-cost analysis. As a point of departure we take the model of perfect competition and proved for that model that the benefit-cost criterion is a restatement of the first order optimality conditions of the perfectly competitive model.

In the case of developed economies one generally assumes that market prices are an acceptable approximation to equilibrium prices as could be derived under a model of perfect competition. Under such conditions market prices reflect the social opportunity cost of the factors of production. Nevertheless the environment of the economies of developing countries are significantly different from those commonly associated with the model of perfect competition. In this sense there exist a series of market imperfections which make it impossible to satisfy the conditions of equilibrium required for an optimal distribution of resources.

Commonly such disequilibria are associated with certain market distortions due to monopolistic elements, price controls, institutionally determined wage rates, fixed exchange rates, rigidity in interest rates, capital rationing, the existing of surplus labor, etc.

Given these conditions the prices of the system do not reflect the true opportunity cost of the factors of production. Consequently the evaluation of an economic rearrangement based on market prices would result in an inefficient distribution of resources. Prices then do not reflect the social costs and benefits of using and producing different commodities.

Given this situation the problem reduces to that of adjusting market prices in such a form so as to obtain the relevant shadow prices which reflect the true social opportunity cost of the factors of production, particularly with respect to strategic inputs such as capital, labor and foreign exchange.

With this in mind we proceeded to develop and analyze current methodologies which try to determine the correct form of estimating the shadow price of labor, the shadow price of foreign exchange, the shadow price of investment and the social rate of discount. In each case we have presented the theoretical basis for the estimation of these parameters, and the advantages and disadvantages of each method.

Subsequently we develop the methods of social evaluation which we then apply to twelve selected projects. First we analyze separately the two methodological variants of benefit-cost analysis referred to as the ONUDI method, whose principal author was Marglin and the other referred to as the OCDE method whose principal authors were Little and Mirrlees. When we compare these procedures we find that both methods utilize the method of discounted cash flows. This leads to the expression of profitability indexes in terms of net present value, the benefit-cost ratio and in terms of the internal rate of return. The method of Marglin actualizes costs and benefits in terms of consumption. Little and Mirrlees utilize investment goods as the numeraire. Another difference between the OCDE method and the ONUDI method is that the former utilizes border prices in the numeraire whereas the latter utilizes domestic prices in the numeraire. Both procedures adjust market prices by means of the estimation of shadow prices. The principal characteristic of the UNIDO method is the weighting of consumption generated by each group that participates in the project. That is to say the Marglin method weights the flows of costs and benefits according to the marginal propensities to consume and to invest of each economic group. The OCDE method only differentiates between the source of funds as between the private and public sector.

On the other hand the social marginal productivity method as proposed by Chenery determines the annual increment in national income and the balance of payments effect per unit of project investment. Basically this method jointly values the capital turnover rate and the balance of payments effect of an investment project.

The semi input-output method incorporates in the evaluation of projects the intersectoral effects. This method divides the input-output matrix in two rectangular sub-matrixes grouping to which correspond national and international sectors respectively. The national sectors are defined by those sectors whose products or services are restricted to the internal market because of technical, economic or structural reasons. The contrary is the case for international sectors.

In this form the benefits of a project are evaluated in relation to changes in the level of production of a group of interrelated national sectors.

In order to have a global vision of the Peruvian economy we have included a small descriptive section which highlights the behavior of the principal global and sectoral indicators of the Peruvian economy for the period 1968-1975. We have given greater emphasis to the behavior of aggregate variables on the expenditure side, and especially to the program of public investment implemented during this period. Within this we have highlighted the contribution of the principal projects, their objectives and their source of financing.

With respect to the twelve projects selected for economic evaluation we must indicate that these projects have been selected under the conviction that they are the most representative within their respective sectors and that they reflect the strategy pursued by the government in the investment field. In absolute amounts these twelve projects constitute approximately seventy percent of investment under actual implementation.

For the agricultural sector we have chosen the irrigation projects Chira-Piura, Olmos, Jequetepeque and Majes. For the industrial sector we chose the La Pampilla oil refinery, the Fertilizer Plant, the Steel Plant and the Yura cement project. For the mining sector we chose the Ilo copper refinery, the Michiquillay copper production project, the

Cajamarquilla zinc refinery and the Cerro Verde copper production project. We give a summary description of each project, their principal characteristics, their costs, and their expected benefits.

The basic information for these projects is provided by the respective feasibility studies, which was complemented by information from other sources so as to check the consistency of these studies as well as to obtain the necessary division in of labor machinery, materials both in terms of national and foreign exchange components.

On the other hand given the tendency to underestimate the costs and overestimate the benefits it has been necessary to adjust the estimates according to opinion sampling realized both in the office and at the field level and in other cases according to the statistics for prices and production.

Once we verified and adjusted the components of investment and production we then actualized the studies on the basis of 1976 prices. This adjustment was necessary in order to express costs and benefits of the selected projects with respect to the same base year, which allows us to compare one project with another. For the purpose of the conversion to the same base year we utilized the deflators listed in Table 6.1.

Subsequently we proceeded to realize the social evaluation of these projects so as to obtain a ranking of these according to the different indexes of profitability obtained. The method proposed by Marglin is applied in three successive stages which allow us to appreciate the influence on the indexes of profitability the incorporation of the separate assumptions and adjustments which convert a stricted financial analysis into a social benefit-cost analysis. The results of Alternative I of Marglin based on market prices, show that with the exception of the Cerro Verde and Majes project, the remainder of the projects are financially profitable.

For the irrigation projects we observe that the net present value ranking and the benefit-cost ratio are stable. They place the Chira-Piura and Olmos project in the first two places. The internal rate of return ranking considers the Olmos project as the most profitable because of its larger period of construction. For the industrial projects we observe that the benefit-cost ratio and the internal rate of return yield identical rankings, placing the La Pampilla oil refinery and the Steel Plant in the first two positions. The net present value ranking give first position to the Steel plant because of its large annual value of production relative to the La Pampilla refinery project. For the mining projects we observe that the three indexes of commercial profitability such as net present value, benefit-cost ratio and the internal rate of return yield the same ranking, placing the Ilo refinery and Cajamarquilla project in the first two positions.

If we take the twelve projects together we observe that there does not exist a sectoral predominance in the global ranking. Nevertheless, the Steel Plant, the La Pampilla oil refinery, the Ilo project and the Chira-Piura and Olmos irrigation projects occupy the first five positions of the global ranking with respect to all indexes of profitability considered in this alternative.

The inclusion of shadow prices for labor and foreign exchange as under Alternative II increases the indexes of profitability for all projects with the result that all are considered to be socially profitable.

The ranking of the agricultural projects is stable for the three indexes of profitability, placing the Chira-Piura and Olmos projects in the first two positions. The Majes project always obtains the last position in the sectoral ranking. On the other hand the ranking of the industrial projects is unstable with respect to the three indexes of profitability, although the Yura cement project always comes in last position. For the ranking of the benefit-cost ratio and the internal rate of return criterion the La Pampilla oil refinery occupies first place, but in the net present value calculations the Steel plant displaces it because of its larger annual production.

With respect to the mining projects we also observe that the results given the utilization of the three indexes of profitability are unstable. In the net present value ranking the Cerro Verde and Michiquillay projects occupy the first two positions because of their foreign exchange earnings and because of the value of annual production which are significantly larger than those for the Ilo and Cajamarquilla projects. On the other hand when we utilize the benefit-cost ratio and internal rate of return ranking the Ilo project becomes the most profitable displacing the Cerro Verde project now to last position. If we take all twelve projects together one observes that the net present value ranking favors projects with the larger annual production of export oriented projects such as mining projects. On the other hand the benefit-cost ratio and the internal rate of return ranking favor agricultural projects and to a lesser extent the industrial projects.

The inclusion of weighting factors for consumption, as under Alternative III, increases the social profitability of industrial and mining projects. The irrigation projects are severely affected decreasing their indexes of social profitability. The Majes project is the only project, however, which obtains a negative social profitability. This deterioration in the profitability of irrigation projects is due to the fact that their investment costs increase according to the weight assigned to government consumption, whereas benefits increase in a smaller proportion according to the weighting given to the consumption by farmers.

We must indicate that the ranking of the mining and industrial projects maintain as between themselves the ranking as obtained by the second alternative of Marglin, because the weighting factors affects both costs and benefits almost proportionally.

On the other hand the method proposed by Little and Mirrlees, as under Alternative IV are quite stable and comparable to those obtained under Alternative II by Marglin, because the assumptions and parameters utilized in both methods are quite the same, with exception that in Alternative IV salaries and wages during the construction and operation phase are expressed in terms of consumption generated.

We applied a sensitivity analysis only for Alternative III of the Marglin method. For this purpose we assumed a social rate of discount respectively equal to 8 percent, 10 percent and 12 percent. Similarly we assign a foreign exchange premium of 50 percent and 70 percent over the current market price. For the shadow price of labor we also considered this wage rate with and without indirect effects which are associated with the shadow price of investment. According to the results obtained, we observe that to the extent that the social rate of discount decreases from 12 percent to 8 percent, the shadow price of investment will increase, which in turn increases to a larger extent the weighting factor of consumption of those economic groups which have a larger propensity to save.

The projects mostly affected by the consideration of a smaller rate of discount are the irrigation projects, because as we indicated the investment costs to be assumed by the government increase to a larger extent, than the benefits generated by the farmers. On the other hand, the inclusion of indirect effects in the estimation of the shadow price of labor determines that the shadow wage rate be larger than the market wage rate, which affects paradoxically those projects most intensive in labor such as the irrigation projects.

In the application of Chenery's social marginal productivity method we have considered also three analytical alternatives. In Alternative I we proceeded to calculate the indexes of social marginal productivity taken the total investment as an absolute figure. Costs and benefits are represented by the values sustained by the project once it reaches full production, without taking into account any possible discounting process. In Alternative II we proceed to express the total cost of the project and the annual production and cost flows and the corresponding balance of payments effect in terms of annual equivalents. Alternative III is similar to Alternative II, except that we also allow for a shadow price for labor.

The sectoral ranking of mining and industrial projects are quite stable for the three alternatives of the social marginal productivity criterion, when the shadow price is 1.5 times the market price for foreign exchange. In the industrial sector the La Pampilla and the Steel plant occupy the first two positions. In the mining sector the Ilo and Cajamarquilla project are considered as the most profitable. On the other hand the ranking of the irrigation projects is stable only for Alternatives II and III. Both place the Chira-Piura and Jequetepeque project in the first two positions. The indexes of social marginal productivity obtained in the three alternatives classify all twelve projects as socially profitable. We must mention thatthe hypothesis of Chenery is confirmed for all three of these alternatives, that is to say that the sectoral ranking given by the capital turnover ratio is the same as that provided by the social marginal productivity criterion.

On the other hand the results generated by the utilization of the semi input-output method is quite similar to that obtained by the benefit-cost ratio and the social marginal productivity method. The ranking of the industrial and mining projects is quite similar to that obtained under the above mentioned methods. With respect to the irrigation projects, the semi input-output method selects the Jequetepeque project as the most profitable. The Majes project as with the previous methods occupies last place. According to the indexes of profitability obtained all projects prove to be profitable.

Subsequently we make a comparison of the results taking as a base the ranking obtained by the utilization of the benefit-cost ratio for Alternatives II and III for Marglin and Alternative III for Chenery's social marginal productivity criterion. In this comparative analysis we observe that the performance of the irrigation projects with the exception of the Majes project is outstanding given that they occupy the third, fourth and fifth place in the global ranking under Alternative II as proposed by Marglin. In the global ranking on the basis of the social marginal productivity criterion, the irrigation projects even improve their ranking, now occupying the second, third and fifth place within the global ranking. This improvement in their position is due to the fact that in the social marginal productivity criterion the foreign exchange effect is less intensive which reduces the relative profitability of mining projects. In general the Chira-Piura and the Majes project always occupy the first and fourth place in sectoral ranking, whereas the Jequetepeque and Olmos project interchange positions according to the method of analysis utilized.

The performance of industrial projects is stable for the three alternatives considered and compared both at the sectoral and global ranking. In the global ranking the La Pampilla refinery, the Steel plant and the Fertilizer project occupy the first, sixth and seventh position respectively. The Yura cement project is the least profitable. It shares with the Majes project last place.

For the mining projects we observe that the Ilo refinery occupies the second place in the global ranking of Alternative III as proposed by Marglin, but is displaced to a fourth position when we utilize the social marginal productivity ranking. The remaining mining sectoral projects are located in the eighth, ninth and tenth position. In the sectoral ranking the Ilo refinery and the Cerro Verde project always occupy the first and fourth place respectively. On the other hand the Michiquillay and Cajamarquilla projects interchange a third and fourth position.

The adoption of Alternative III as proposed by Marglin affects the ranking of the irrigation projects considerably because of the high weight given to consumption by the government. The mining and industrial projects improve their positions relative to the irrigation projects but maintain internally their relative ranking as obtained under Alternative II.

Finally we summarize in the following lines the most important findings of this study.

One observes that the formulation and preparation of the feasibility studies are somewhat limited in the sense that such studies do not consider technological alternatives, particularly as to the comparative advantages of more or lesser capital intensity projects, and their differential reliance on foreign exchange. Similarly there do not exist as of now specific instructions as to the preparation and evaluation of such studies from the social-economic point of view. In the review of these feasibility studies we found a marked heterogeneity as to concepts, definitions, evaluation methods, conventions and methods of presentation utilized. These differences make it difficult to identify the principal variables and indicators which must serve in the selection and comparison as between these projects. When we take together the different methods and indexes of profitability used in this study we would like to indicate that each one of them has been designed to quantify one specific objective. All of them, however, do coincide in the selection of projects that happen to be profitable or nonprofitable. But within this, the rankings obtained are unstable. Hence the importance of relating the evaluation criteria to the purpose and necessity of analysis. According to the results of comparative analysis we observe that the sectoral rankings are quite stable, but that the global rankings varies very substantially from one method to the other. This indicates that the ranking generated by different methods of evaluation is the same for projects within a sector but quite different when one compares projects between one sector and the other. With respect to the consistency between the projects evaluated in this study and national objectives such as growth, employment and foreign exchange generation, we must indicate that each group of projects contributes to a lesser or greater extent to each of these objectives. Each sector, however, tends to have a predominance in one or another partial objective. If one does not clearly specify the objectives which one hopes to reach with a program of investment which balances partial objectives one can not necessarily reject a project which will achieve one or another of these objectives in isolation. Finally we may observe that all of the projects evaluated here are considered to be socially profitable with the exception of the Majes irrigation project under certain assumptions. This in general would indicate that the government's public investment project as currently constituted is in general terms well conceived.

According to the results obtained one does not observe the predominance in the global ranking of one sector relative to another. Nevertheless it may be somewhat surprising to many knowledgeable persons that the ranking of the irrigation projects is superior to that of mining and industrial projects.

For its part the methods of social benefit-cost analysis give us an efficient instrument for the evaluation, selection and ranking of projects. Nevertheless the final composition of an investment program may have to include certain very specific targets closely related to one or several national objectives.

Finally the social benefit-cost evaluation of a project should be realized both in the pre-investment stage, during the investment stage and during the production stage, coinciding respectively with the study, construction and operation phases of the project.

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X. APPENDIX A

Table A.1. Gross domestic product by expenditure category at constant 1970 market prices, 1968-74

	1968	1969	1970	1971	1972	1973	1974
				(billion soles)			
Gross domestic product	215.3	224.3	240.7	253.2	268.2	282.6	301.3
Consumption	175.9	184.7	199.8	208.2	219.3	243.0	261.1
Public	27.4	27.7	29.0	30.8	33.1	37.7	40.7
Private	148.5	157.0	170.8	177.4	186.2	205.3	220.4
Gross investment	27.8	28.7	31.1	38.7	38.8	41.8	52.1
Fixed investment	25.9	26.7	29.9	33.0	35.1	39.5	51.1
Public	(7.6)	(9.1)	(10.9)	(12.7)	(13.6)	(16.1)	(26.8)
Private	(18.3)	(17.6)	(19.0)	(20.3)	(21.5)	(23.4)	(24.3)
Stock changes	1.9	2.0	1.2	5.7	3.7	2.3	1.0
Exports	47.6	46.5	47.5	45.5	49.3	39.6	42.7
Imports	35.8	35.6	37.7	39.2	39.2	41.8	54.6

Table A.2. Gross domestic product by expenditure category, real growth rates, 1969-74

	1969	1970	1971	1972	1973	1974	Average 1968-74
			(annual rates, percent)				
Gross domestic product	4.1	7.3	5.2	5.9	5.4	6.6	5.8
Consumption	5.1	8.1	4.2	5.4	12.4	7.9	6.8
Public	1.0	4.9	6.6	8.5	12.6	8.7	6.8
Private	5.9	8.7	3.8	4.8	12.4	7.8	6.8
Gross investment	3.1	8.3	25.0	-	7.6	21.5	11.0
Fixed investment	3.0	12.2	10.0	6.9	17.4	20.6	12.0
Public	(19.0)	(20.1)	(15.5)	(8.7)	(23.8)	(42.1)	(23.4)
Private	(-3.7)	(8.1)	(6.8)	(5.8)	(13.4)	(5.7)	(4.8)
Stock changes	-	-	-	-	-	-	-
Exports	-2.4	2.2	-4.1	8.1	-19.7	8.1	-1.7
Imports	-0.6	5.6	4.2	-0.3	6.6	30.6	7.3

Table A.3. Gross domestic product by expenditure category, 1968-74

	1968	1969	1970	1971	1972	1973	1974
		(structure, percentages of total)					
Gross domestic product	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Consumption	84.5	83.8	83.0	84.1	85.2	85.7	88.0
Public	13.0	12.2	12.0	12.5	13.0	12.7	12.3
Private	71.5	71.6	71.0	71.6	72.2	73.0	75.7
Gross investment	13.9	13.3	12.9	15.0	14.1	14.3	16.4
Fixed investment	13.0	12.4	12.4	12.6	12.8	13.3	16.1
Public	(3.8)	(4.2)	(4.5)	(4.8)	(5.0)	(5.5)	(8.5)
Private	(9.2)	(8.2)	(7.9)	(7.8)	(7.8)	(7.8)	(7.6)
Stock changes	0.9	0.9	0.5	2.4	1.3	1.0	0.3
Exports	20.6	19.7	19.7	16.0	15.4	15.0	16.1
Imports	19.0	16.8	15.6	15.1	14.7	15.0	20.5

Table A.4. Gross domestic product by sectoral origin, real growth rates, 1969-74

	1969	1970	1971	1972	1973	1974
	(annual rates, percent)					
Gross domestic product	4.1	7.3	5.2	5.9	5.4	6.6
Agriculture	6.6	7.8	3.0	-	2.4	2.3
Fishing	-10.0	34.0	-13.4	-48.4	-23.6	40.9
Mining	9.9	5.1	-2.8	6.4	0.7	2.5
Manufacturing	2.1	10.2	12.1	12.7	7.5	8.0
Construction	6.7	13.6	10.5	12.4	8.2	17.0
Electricity, gas and water	5.0	4.6	7.6	5.7	6.0	9.0
Ownership of dwellings	3.1	-0.2	4.5	4.6	4.5	4.7
Administration and defense	2.0	4.3	6.5	7.0	7.0	5.5
Commerce	9.9	4.7	8.3	5.4	6.0	6.0
Other	6.0	5.2	1.9	6.2	6.3	7.8

Table A.5. Gross domestic product by sectoral origin, 1968-74

	1968	1969	1970	1971	1972	1973	1974
	(structure, percentages of total)						
Gross domestic product	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Agriculture	14.7	15.0	15.1	14.8	14.0	13.6	13.0
Fishing	2.6	2.2	2.8	2.3	1.1	0.8	1.1
Mining	8.7	8.3	8.2	7.5	7.6	7.3	7.0
Manufacturing	23.0	22.6	23.2	24.7	26.2	26.8	27.0
Construction	3.9	3.8	4.2	4.4	4.6	4.8	5.2
Electricity, gas and water	1.3	1.3	1.2	1.3	1.3	1.3	1.3
Ownership of dwellings	4.5	4.5	4.1	4.0	4.0	4.0	3.9
Administration and defense	8.7	8.5	8.3	8.4	8.5	8.6	8.5
Commerce	13.4	14.1	13.8	14.2	14.2	14.3	14.1
Other	19.2	19.7	19.1	18.4	18.5	18.5	18.8

Table A.6. Gross capital formation of the public sector, by institutional origin, 1968-75

	1968	1969	1970	1971	1972	1973	1974	1975
				(million soles)				
Central government	2,603	2,912	5,765	7,115	8,503	7,593	14,937	15,564
Public enterprises	2,557	4,307	3,852	4,042	5,117	10,648	19,935	32,198
Public institutions and social security	1,519	1,140	571	580	362	377	897	920
Local governments	423	473	709	1,051	850	1,243	1,400	1,438
Total	7,102	8,832	10,897	12,788	14,832	19,861	37,169	50,120

Table A.7. Public investment: Major projects

	Total cost (million soles)	Beginning of operations (year)
Agriculture		
Chira-Piura	11,780	1978
Majes	14,757	1981
Olmos	11,396	progressive
Jequetepeque	5,922	1980
Tinajones I	10,000	1981
Power and mining		
Cerro Verde I	7,276	1977
Cerro Verde II	90,436	1982
Ilo I	2,196	1976
Ilo II	5,892	1980
Cajamarquilla	11,505	1980
Michiquillay	35,752	1981
La Pampilla	5,634	1976
Pipeline	27,000	1978
Mantaro I and II	22,525	1978
Fisheries		
Paita complex	1,600	1977
La Puntilla complex	1,350	1976
Samanco complex	962	1978

	Total cost (million soles)	Beginning of operations (year)
Transport and communications		
Oroya-Aguaytia	4,013	1978
Tarapoto-Serrayanacu	1,382	progressive
Callejon de Huaylas	1,622	1977
Railroad rehabilitation	2,679	1978
Telecommunications network	1,007	1976
National telex network	671	1976
Industry		
Steel plant expansion	65,907	1980
Metal work complex	732	1977
Newsprint plant	2,786	1977
Urea plant	3,635	1979
Health and Sanitation		
National rural water supply and sewerage	1,437	1976
Hospitals network	1,556	1979

Table A.8. Public investment program by sectoral origin, 1968-75

	1968	1969	1970	1971
		(million soles)		
Productive sectors	1,854	4,128	2,008	2,982
Agriculture	537	387	676	811
Industry and tourism	271	2,041	480	462
Mining and hidrocarbons	1,034	1,700	780	1,646
Fisheries	12	-	72	63
Physical infrastructure	2,666	2,212	5,358	4,994
Transport and communications	2,666	2,212	3,770	3,602
Power	-	-	1,588	1,392
Social sectors	915	686	1,104	1,125
Education	176	149	333	356
Health	204	214	168	103
Housing	535	323	603	666
Other	1,667	1,806	2,427	3,687
Total	7,102	8,832	10,897	12,788

1972	1973	1974	1975	1968	1975
(million soles)				(percentage)	
4,689	8,806	16,553	33,974	26	68
2,083	2,702	4,707	6,021	8	12
214	235	887	3,495	4	7
2,046	5,447	9,776	22,207	14	44
346	422	1,183	2,071	-	5
4,479	5,210	7,171	8,880	38	17
2,587	3,010	4,286	4,480	38	9
1,892	2,200	2,885	4,400	-	8
2,013	1,911	2,853	3,617	13	7
702	844	1,468	1,300	2	3
273	213	294	1,149	3	2
1,038	854	1,091	1,168	8	2
3,651	3,754	10,592	3,649	23	8
14,832	19,681	37,169	50,120	100	100

Total A.9. Public investment program by regional origin, 1968-75

	1968	1969	1970	1971	1972	1973	1974	1975
	(structure, percentage of total)							
North	17	33	17	23	21	26	22	23
Central	21	18	12	20	21	19	11	7
Lima metropolitan	14	11	12	10	12	8	8	9
South	14	10	18	13	15	14	18	21
East	5	8	9	11	14	13	25	25
Multiregional	29	20	32	23	17	20	16	15
Total	100	100	100	100	100	100	100	100

Table A.10. Public investment program and its financing, 1968-75

Source	1968	1969	1970	1971	1972	1973	1974	1975
				(million soles)				
Public treasury	3,230	3,689	6,779	6,505	6,087	8,724	14,194	15,248
Capital revenue	179	265	565	3,193	4,157	2,917	3,569	3,989
Internal debt	105	53	8	412	957	341	864	3,712
External debt	3,588	4,825	3,520	2,583	3,508	7,795	18,463	27,171
External transfers	-	-	25	95	123	84	79	-
Total	7,102	8,832	10,897	12,788	14,832	19,861	37,169	50,120

Table A.11. Saving-investment gap

Year	National savings (1)	Gross domestic investment (2)	Gap (1-2)	Ratio (1)/(2)
	(million soles)			(percentage)
1968	20,232	25,783	-5,551	78
1969	24,128	27,863	-3,735	87
1970	35,967	31,049	4,918	116
1971	37,614	39,536	-1,922	95
1972	38,992	41,834	-2,842	93
1973	41,986	50,682	-8,696	83
1974	47,637	72,416	-24,779	66
1975	41,136	105,985	-64,845	39

Table A.12. Central Government cash operations, 1969-76

	1969	1970	1971	1972	1973	1974	1975-76
	(billion soles)						
Current revenues	32.3	38.9	41.7	45.6	53.4	69.3	188.6
Current expenditures	28.2	32.1	36.9	42.0	52.5	62.3	191.0
Current account surplus or deficit	4.1	6.8	4.8	3.6	0.9	7.0	-2.4
Capital expenditures	6.0	9.5	12.5	14.1	15.4	21.4	64.9
(Gross fixed investment)	(2.9)	(5.8)	(7.1)	(8.5)	(7.6)	(14.9)	n.a.
Overall surplus or deficit	-2.0	-3.2	-8.1	-10.8	-14.6	-14.4	-67.3
Financing							
External, net	1.3	1.6	-0.4	2.2	7.0	11.2	23.2
Domestic, net	0.7	1.6	8.5	8.6	7.6	3.2	44.1

Table A.13. Public enterprises cash operations, 1969-74

	1969	1970	1971	1972	1973	1974
			(billion soles)			
Current revenues	7.8	10.2	11.5	15.1	21.3	29.0
Current expenditures	6.2	7.5	9.9	12.7	21.9	31.6
Current account surplus or deficit	1.6	2.7	1.6	2.4	-0.6	-2.6
Capital revenue[1]	1.0	0.8	2.9	3.0	3.9	4.3
Capital expenditures	4.8	4.9	4.2	5.4	11.2	21.4
(Gross fixed investment)	(4.3)	(3.8)	(4.0)	(5.1)	(10.6)	(19.9)
Overall surplus or deficit	-2.2	-1.4	0.3	-	-7.8	-19.8

XI. APPENDIX B

Table B.1. Unadjusted and adjusted output and cost data, Chira-Piura project

Item	Feasibility studies base year = 1967 (million soles)
Total output	1632.8
Domestic currency	1274.8
Foreign currency	520.7
Agricultural income foregone	162.7
Total investment	5718.5
Domestic currency	3838.6
Construction and equipment	428.6
Labor	480.5
Assistance and supervision	613.1
Administrative costs	223.6
Farm development	2092.8
Foreign currency	1879.9
Operating costs	1324.6
Production costs	761.1
Labor	545.5
Maintenance and administrative costs	13.5
Foreign currency	4.6

[a] The output and production costs adjustments have been made according to tables B.2. and B.3.

[b] Rate of exchange US $1.00 = s/.70.0.

Deflator[a]	Adjusted 1976 prices (million soles)	(million dollars)[b]
-	4778.1	68.3
-	3624.8	51.8
-	1480.6	21.2
-	327.3	4.7
-	11780.6	168.3
-	8114.8	115.9
1.94	831.5	11.9
3.33	1600.0	22.9
1.94	1189.5	17.0
1.94	433.8	6.2
1.94	4060.0	58.0
1.95	3665.8	52.4
-	29563.4	42.3
-	1705.8	24.3
-	1222.6	17.5
1.94	26.0	0.4
1.95	9.0	0.1

Table B.2. Unadjusted and adjusted gross production and costs, Piura valley at full output

Product	Cultivated hectares No.	Cultivated hectares %	Gross Production per hectare Unadjusted[a] (soles)	Gross Production per hectare Adjusted[b] (soles)
Cotton	31326	46.7	18994	40270
Rice	9762	14.6	13936	51367
Corn	6506	9.7	10864	25960
Grains	8057	12.0	8363	21112
Potato	6705	10.0	11508	87380
Citrics	670	1.0	21964	42067
Bananas	670	1.0	19320	65764
O. Fruits	670	1.0	18553	50200
Orchards	2689	4.0	14312	51860
Total	67055	100.0	15283	43743
Lower Piura	54135	80.7	15347	43040
Middle Piura	12920	19.3	15015	46687
Without project	44615	-	13925	31576

[a]Feasibility study projections (base year = 1969).

[b]1976 prices.

[c]The agricultural income foregone is given by the difference between 1408.8 and 1199.0.

Production costs per hectare		Gross production		Production costs	
Unadjusted[a]	Adjusted[b]	Unadjusted[a]	Adjusted[b]	Unadjusted[a]	Adjusted[b]
(soles)		(million soles)		(million soles)	
13450	27071	595.0	1261.5	421.3	848.0
10750	23950	136.0	501.4	104.9	233.8
7780	15759	70.7	168.9	50.6	102.5
10411	14620	67.4	170.1	83.9	117.8
9720	49636	77.2	585.9	65.2	332.8
15900	23620	14.7	28.2	10.0	15.8
8962	27000	12.9	44.1	6.0	18.0
11760	23510	12.4	33.6	7.9	15.7
11370	20150	38.5	139.5	30.6	54.2
11647	25928	1024.8	2933.2	781.0	1738.6
11974	26655	830.8	2330.0	648.2	1443.0
10278	22879	194.0	603.2	132.8	295.6
12078	26880	621.3	1408.8[c]	538.8	1199.0[c]

Table B.3. Unadjusted and adjusted gross production and costs, Chira valley at full output

Product	Cultivated No.	Cultivated %	Gross production per hectare (soles) Unadjusted[a]	Gross production per hectare (soles) Adjusted[b]
Cotton	14810	24.6	15200	42351
Rice	3346	5.5	9600	51658
Corn	3133	5.2	13354	25667
Forage	13314	22.1	2020	8886
Beans	4806	8.0	5040	23128
Alfalfa	4877	8.1	14600	44770
Bananas	1673	2.8	28000	66328
Dates	1673	2.8	33000	64344
Citrics	3774	6.3	27200	42150
O. Fruits	3062	5.1	17612	52320
Orchards	5874	9.7	15470	52125
Total	60316	100.0	12778	36014
Without project	47653	-	7737	16248

[a]Feasibility study projection (base year = 1967).

[b]1976 prices.

[c]The agricultural income foregone is given by the difference between 774.3 and 656.8.

Production costs per hectare		Gross production		Production costs	
Unadjusted[a] (soles)	Adjusted[b]	Unadjusted[a] (million soles)	Adjusted[b]	Unadjusted[a] (million soles)	Adjusted
12250	26580	225.1	627.2	181.4	393.6
8000	23740	32.1	172.8	26.8	79.4
7650	15350	41.8	80.4	24.0	48.1
1220	4624	26.9	118.3	16.2	61.6
4000	13964	24.2	111.1	19.2	43.7
11600	18236	71.2	218.3	56.6	88.9
17000	26973	46.8	111.0	28.4	45.1
18100	29865	55.2	107.6	30.3	50.0
15000	22315	102.6	159.1	56.6	84.2
10850	23968	53.9	160.2	33.2	73.4
8500	20745	90.9	306.2	49.9	121.8
8664	19726	770.7	2172.2	522.6	1189.8
6055	13783	368.7	774.3[c]	288.5	656.8[c]

Table B.4. Chira-Piura project: Benefits, costs by year (at market prices)

Item		Year: 1	2	3
Agricultural output	(B_t)	-	-	-
Domestic currency	(B_t^n)	-	-	-
Foreign currency	(B_t^f)	-	-	-
Agricultural income foregone	(O_t)	-	-	-
Total investment	(K_t)	321.8	691.7	714.1
Domestic currency	(K_t^n)	213.4	352.6	356.7
Construction and equipment		24.6	76.9	81.0
Labor		60.0	140.0	140.0
Assistance and supervision		92.8	99.7	99.7
Administratives costs		36.0	36.0	36.0
Farm development		-	-	-
Foreign currency	(K_t^f)	108.4	339.1	357.4
Operating costs	(C_t)	-	-	-
Domestic currency	(C_t^n)	-	-	-
Production costs		-	-	-
Labor		-	-	-
Maintenance and administrative costs		-	-	-
Foreign currency	(C_t^f)	-	-	-
Salvage value	(V_t)	-	-	-

4	5	6	7 (million soles)	8	9	10
-	2257.7	2473.2	2688.6	2796.3	2904.0	3011.7
-	1835.4	1988.4	2141.3	2217.8	2294.2	2370.7
-	749.6	812.1	874.6	905.8	937.1	968.3
-	327.3	327.3	327.3	327.3	327.3	327.3
683.7	735.7	655.7	711.9	705.7	767.7	716.8
408.2	417.8	403.0	413.4	412.2	423.7	415.0
62.5	72.1	57.3	67.7	66.5	78.0	70.3
140.0	140.0	140.0	140.0	140.0	140.0	140.0
99.7	99.7	99.7	99.7	99.7	99.7	99.7
36.0	36.0	36.0	36.0	36.0	36.0	36.0
70.0	70.0	70.0	70.0	70.0	70.0	70.0
275.5	317.9	252.7	298.5	293.5	344.0	300.8
-	1818.6	1967.0	2116.0	2190.3	2264.9	2338.9
-	1809.6	1958.0	2107.0	2181.3	2255.6	2329.9
-	1034.5	1120.6	1207.0	1250.1	1293.2	1336.3
-	749.1	811.4	874.0	905.2	936.4	967.6
-	26.0	26.0	26.0	26.0	26.0	26.0
-	9.0	9.0	9.0	9.0	9.0	9.0
-	-	-	-	-	-	-

Table B.4. (continued)

Item	11	12	13	14
Agricultural output	3119.4	3205.6	3334.8	3377.9
Domestic currency	2447.2	2508.4	2600.1	2630.7
Foregn currency	999.5	1024.5	1062.0	1074.5
Agricultural income foregone	327.3	327.3	327.3	327.3
Total investment	791.7	854.1	70.0	70.0
Domestic currency	428.1	439.7	70.0	70.0
Construction and equipment	82.4	94.0	-	-
Labor	140.0	140.0	-	-
Assistance and supervision	99.7	99.7	-	-
Administratives costs	36.0	37.8	-	-
Farm development	70.0	70.0	70.0	70.0
Foreign currency	363.6	414.4	-	-
Operating costs	2413.2	2472.7	2561.8	2591.6
Domestic currency	2404.2	2463.7	2552.8	2582.6
Proudction costs	1379.4	1413.9	1465.4	1482.9
Labor	988.8	1023.8	1061.3	1073.7
Maintenance and administrative costs	26.0	26.0	26.0	26.0
Foreign currency	9.0	9.0	9.0	9.0
Salvage value	-	-	-	-

15	16	17-60	61
3550.3	4365.7	4778.1	5395.7
2753.1	3332.0	3624.8	3624.8
1124.5	1361.0	1480.6	1480.6
327.3	327.3	327.3	327.3
70.0	70.0	70.0	70.0
70.0	70.0	70.0	70.0
-	-	-	-
-	-	-	-
-	-	-	-
-	-	-	-
70.0	70.0	70.0	70.0
-	-	-	-
2710.5	2859.2	2963.4	2963.4
2701.5	2850.2	2954.4	2954.4
1551.8	1638.0	1705.8	1705.8
1123.7	1186.2	1222.6	1222.6
26.0	26.0	26.0	26.0
9.0	9.0	9.0	9.0
-	-	-	617.6

Table B.5. Unadjusted and adjusted output and cost data, Jequetepeque project

Item	Feasibility studies base year = 1972 (million soles)
Total output	2626.3
Domestic currency	2154.3
Foreign currency	756.7
Agricultural income foregone	284.7
Total investment	3306.2
Domestic currency	1816.8
Construction and equipment	834.5
Labor	534.6
Assistance and supervision	145.6
Administrative costs	64.5
Farm development	237.6
Foreign currency	1489.4
Operating costs	1836.2
Production costs	1124.6
Labor	660.5
Maintenance and administrative costs	43.5
Foreign currency	7.6

[a] The output and production costs adjustments have been made according to table B.6.

[b] Rate of exchange US $1.00 = s/.70.0.

Deflator[a]	Adjusted 1976 prices (million soles)	(million dollars)[b]
-	3829.7	54.7
-	3062.5	43.7
-	1075.8	15.4
-	308.6	4.4
-	5922.0	84.6
-	3360.2	48.0
1.72	1435.4	20.5
2.16	1154.8	16.5
1.72	250.4	3.6
1.72	110.9	1.6
1.72	408.7	5.8
1.72	2561.8	36.6
	2181.1	31.2
-	1318.6	18.8
-	774.5	11.1
1.72	74.9	1.1
1.72	13.1	0.2

Table B.6. Unadjusted and adjusted gross production and costs, Jequetepeque project at full output

Product	Cultivated hectares		Gross production per hectare (soles)	
	No.	%	Unadjusted[a]	Adjusted[b]
Rice	26102	24.7	35484	49845
Corn (feed)	22981	21.7	15755	28424
Sorgum	17822	16.8	14993	15563
Soybeans	6625	6.3	10460	13131
Beans	3726	3.5	11943	22676
Swt. Potato	65	0.1	7692	14880
Yucca	560	0.5	9464	19842
Vegetables	8045	7.5	28000	49068
Alfalfa	1900	1.8	31421	44139
Fruits	8000	7.6	36000	49637
Sugar cane	8518	8.1	75710	93578
Wheat	1438	1.4	12517	34916
Total project	105782	100.0	27519	39121
Without project	45134	-	24802	28522

[a]Feasibility study projection (base year = 1972).

[b]1976 prices.

[c]The agricultural income foregone is given by the difference between 1287.3 and 978.7.

Production costs per hectare		Gross Production		Production costs	
Unadjusted[a]	Adjusted[b]	Unadjusted[a]	Adjusted[b]	Unadjusted[a]	Adjusted[b]
(soles)		(million soles)		(million soles)	
18820	22791	926.2	1301.1	491.2	594.9
9890	12224	362.1	653.2	227.5	280.9
7660	8122	267.2	277.4	136.5	144.8
7360	7971	69.3	87.0	48.5	52.8
7480	12309	44.5	84.5	27.7	45.9
4290	8017	0.5	1.0	0.3	0.5
5740	11760	5.3	11.1	3.2	6.6
14120	21331	225.3	394.7	113.6	171.6
15220	18431	59.7	83.9	28.8	35.0
19410	22302	288.0	397.1	155.3	178.4
63440	65384	644.9	797.1	540.6	556.9
8230	17256	18.0	50.2	11.9	24.8
16875	19787	2911.0	4138.3	1785.1	2093.1
18495	21685	1119.0	1287.3[c]	834.7	978.7[c]

Table B.7. Jequetepeque project: Benefits, costs by year (at market prices)

Item		Year: 1	2	3
Agricultural output	(B_t)	-	-	-
Domestic currency	(B_t^n)	-	-	-
Foreign currency	(B_t^f)	-	-	-
Agricultural income foregone	(O_t)	-	-	-
Total investment	(K_t)	714.7	1360.2	1023.0
Domestic currency	(K_t^n)	475.5	753.1	608.1
Construction and equipment		330.4	558.0	413.0
Labor		100.0	150.0	150.0
Assistance and supervision		31.3	31.3	31.3
Administratives costs		13.8	13.8	13.8
Farm development		-	-	-
Foreign currency	(K_t^f)	239.2	607.1	414.9
Operating costs	(C_t)	-	-	-
Domestic currency	(C_t^n)	-	-	-
Production costs		-	-	-
Labor		-	-	-
Maintenance and administrative costs		-	-	-
Foreign currency	(C_t^f)		-	-
Salvage value	(V_t)	-	-	-

4	5	6	7	8	9	10-12
			(million soles)			
-	772.4	1190.9	1435.0	1574.5	2620.6	2829.0
-	800.0	1109.6	1290.3	1393.5	2169.4	2322.5
-	281.0	389.9	453.3	489.6	759.8	816.0
-	308.6	308.6	308.6	308.6	308.6	308.6
500.0	408.4	548.9	621.9	646.1	97.9	-
431.5	371.1	444.3	493.2	566.9	97.9	-
151.7	139.9	242.4	291.3	190.8	-	-
150.0	134.2	156.8	156.8	156.8	-	-
31.3	31.3	31.3	31.3	31.3	-	-
13.8	13.8	13.8	13.8	13.8	-	-
84.7	51.9	-	-	174.2	97.9	-
68.5	37.3	104.6	128.7	79.2	-	-
-	678.4	929.6	1076.1	1159.9	1846.2	1971.8
-	672.4	923.6	1070.1	1153.9	1833.1	1958.7
-	408.7	567.0	659.3	712.1	1107.7	1186.8
-	240.1	333.0	387.2	418.2	650.5	697.0
-	23.6	23.6	23.6	23.6	74.9	74.9
-	6.0	6.0	6.0	6.0	13.1	13.1
-	-	-	-	-	-	-

Table B.7. (continued)

Item	13-23	24-27	28-53	54
Agricultural output	3074.0	3308.9	3829.7	4102.7
Domestic currency	2503.2	2677.0	3062.5	3062.5
Foreign currency	879.4	940.5	1075.8	1075.8
Agricultural income foregone	308.6	308.6	308.6	308.6
Total investment	-	-	-	-
Domestic currency	-	-	-	-
Construciton and equipment	-	-	-	-
Labor	-	-	-	-
Assistance and supervision	-	-	-	-
Administratives costs	-	-	-	-
Farm development	-	-	-	-
Foreign currency	-	-	-	-
Operating costs	2118.3	2139.3	2181.1	2181.1
Domestic currency	2105.2	2126.2	2168.0	2168.0
Production costs	1279.1	1292.3	1318.6	1318.6
Labor	751.2	759.0	774.5	774.5
Maintenance and administrative costs	74.9	74.9	74.9	74.9
Foreign currency	13.1	13.1	13.1	13.1
Salvage value	-	-	-	273.0

Table B.8. Unadjusted and adjusted output and cost data, Olmos project

Item	Feasibility studies base year = 1974 (million soles)
Total output	2243.3
Domestic currency	1642.1
Foreign currency	601.2
Total investment	5337.6
Domestic currency	3022.0
Materials and equipment	107.8
Labor	478.2
Assistance and supervision	343.3
Agricultural development cost	2092.7
Foreign currency	2315.6
Operating cost	1547.5
Production costs	839.7
Labor	687.1
Maintenance and administrative costs	15.9
Foreign currency	4.8

[a] The output and production costs adjustments have been made according to table B.9.

[b] Rate of exchange US $1.0 = s/.70.0.

Deflator[a]	Adjusted 1976 prices (million soles)	(million dollars)[b]
-	5444.3	77.8
-	3985.2	56.9
-	1459.1	20.9
	11396.4	162.8
	6834.7	97.6
1.98	213.4	3.1
3.76	1797.9	25.7
1.98	679.7	9.7
1.98	4143.5	59.2
1.97	4561.7	65.2
	3157.9	45.1
-	1714.3	24.5
-	1402.6	20.0
1.98	31.5	0.5
1.97	9.5	0.1

Table B.9. Unadjusted and adjusted gross production and costs, Olmos project at full output

Product	Cultivated hectares		Gross production per hectare	
	No.	%	Unadjusted[a]	Adjusted[b]
			(soles)	
Cotton	22737	24.0	13089	41824
Oil seeds	20144	21.2	10798	36469
Rice	6825	7.2	14300	50985
Maize	4331	4.6	18702	24991
Oranges	2600	2.7	33731	42240
Lemons	1000	1.1	28600	41880
Bananas	2800	2.9	31607	66264
Avocado	1387	1.5	35977	126628
Mango	700	0.7	19000	39967
Pineapple	300	0.3	24333	82160
Vegetables	4097	4.3	38028	51350
Repeat	8200	8.6	8488	20723
Livestock	19830	20.9	44170	99196
Total	94951	100.0	21804	53231
Poultry	-	-	-	-
Total project	-	-	-	-

[a]Feasibility study projection (base year = 1966).

[b]1976 prices.

Production costs per hectare		Gross production		Production costs	
Unadjusted[a] (soles)	Adjusted[b]	Unadjusted[a] (million soles)	Adjusted[b]	Unadjusted[a]	Adjusted[b]
11025	26470	297.6	950.9	250.7	601.8
9096	23823	217.5	734.6	183.2	479.9
7525	23970	97.6	348.0	51.4	163.6
10713	15620	81.0	108.2	46.4	67.6
16000	22425	87.7	109.8	41.6	58.3
15320	22145	28.6	41.9	15.3	22.1
16960	27193	88.5	185.3	47.5	76.1
28360	75620	49.9	175.6	39.3	104.9
6150	9877	13.3	28.0	4.3	6.9
9936	33140	7.3	24.6	3.0	9.9
17950	21044	155.8	210.4	73.5	86.2
3475	7315	69.6	169.9	28.5	60.0
30919	58479	875.9	1967.1	613.1	1159.6
14721	30509	2070.3	5054.3	1397.8	2896.6
-	-	173.0	390.0	129.0	220.0
-	-	2243.3	5444.3	1526.8	3116.9

Table B.10. Olmos project: Benefits, costs by year (at market prices)

Item		Year: 1	2	3
Agricultural output	(B_t)	-	-	-
Domestic currency	(B_t^n)	-	-	-
Foreign currency	(B_t^f)	-	-	-
Total investment	(K_t)	50.4	213.2	233.9
Domestic currency	(K_t^n)	45.8	99.2	106.3
Materials and equipment		13.4	11.0	11.0
Labor		17.7	53.2	60.3
Assistance and supervision		14.7	35.0	35.0
Agricultural development test		-	-	-
Foreign currency	(K_t^f)	4.6	114.0	127.6
Operating costs	(C_t)	-	-	-
Domestic currency	(C_t^n)	-	-	-
Production costs		-	-	-
Labor		-	-	-
Maintenance and administrative ocsts		-	-	-
Foreign currency	(C_t^f)	-	-	-

4	5	6	7 (million soles)	8	9	10	11
-	-	-	217.8	408.3	653.3	909.9	1301.2
-	-	-	159.4	298.9	478.2	666.1	952.5
-	-	-	58.4	109.4	175.1	243.8	348.7
427.9	650.3	746.1	561.3	665.5	411.3	436.7	470.2
154.3	221.7	262.5	219.4	246.0	201.6	208.7	219.4
11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0
108.3	175.7	216.5	99.4	126.0	81.6	88.7	99.4
35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0
-	-	-	74.0	74.0	74.0	74.0	74.0
273.6	428.6	483.6	341.9	419.5	209.7	228.0	250.8
-	-	-	159.4	274.8	415.0	561.5	785.9
-	-	-	149.9	265.3	405.9	552.0	776.4
-	-	-	65.1	128.6	205.7	286.3	409.7
-	-	-	53.3	105.2	168.3	234.2	335.2
-	-	-	31.5	31.5	31.5	31.5	31.5
-	-	-	9.5	9.5	9.5	9.5	9.5

Table B.10. (continued)

Item	12	13	14	15
Agricultural output	1709.5	2155.9	2645.9	3190.4
Domestic currency	1251.4	1578.1	1936.8	2335.4
Foreign currency	458.1	577.8	709.1	855.0
Total investment	439.9	676.7	502.9	420.0
Domestic currency	198.3	248.1	233.9	196.6
Materials and equipment	6.0	6.0	6.0	6.0
Labor	83.3	133.1	118.9	81.6
Assistance and supervision	35.0	35.0	35.0	35.0
Agricultural development cost	74.0	74.0	74.0	74.0
Foreign currency	241.6	428.6	269.0	223.4
Operating costs	1019.7	1275.3	1555.7	1867.5
Domestic currency	1010.2	1265.8	1546.2	1858.0
Production costs	538.3	678.9	833.1	1004.6
Labor	440.4	555.4	681.6	821.9
Maintenance and administrative costs	31.5	31.5	31.5	31.5
Foreign currency	9.5	9.5	9.5	9.5

16	17	18	19 (million soles)	20	21	22	23
3605.9	4066.8	4431.7	4845.4	5014.1	5112.1	5166.6	5242.9
2639.5	2976.8	3244.0	3546.8	3670.3	3742.1	3782.0	3837.8
966.4	1090.0	1187.7	1298.6	1343.8	1370.0	1384.6	1405.1
388.1	356.0	222.6	200.1	94.4	94.4	94.4	94.4
196.6	196.6	145.1	145.1	89.4	89.4	89.4	89.4
6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
81.6	81.6	30.1	30.1	4.4	4.4	4.4	4.4
35.0	35.0	35.0	35.0	5.0	5.0	5.0	5.0
74.0	74.0	74.0	74.0	74.0	74.0	74.0	74.0
191.5	159.4	77.5	55.0	4.5	4.5	4.5	4.5
2132.4	2369.3	2578.1	2815.0	2911.6	2967.7	2998.9	3042.6
2122.9	2359.8	2568.6	2805.5	2902.1	2958.2	2989.4	3033.1
1150.3	1280.6	1395.4	1525.7	1578.8	1609.7	1626.9	1650.9
941.1	1047.7	1141.7	1248.3	1291.8	1317.0	1331.0	1350.7
31.5	31.5	31.5	31.5	31.5	31.5	31.5	31.5
9.5	9.5	9.5	9.5	9.5	9.5	9.5	9.5

Table B.10. (continued)

Item	24	25	26	27-62
Agricultural output	5302.7	5335.4	5389.9	5444.3
Domestic currency	3881.6	3905.4	3945.4	3985.2
Foreign currency	1421.1	1430.0	1444.5	1459.1
Total investment	94.4	94.4	94.4	74.0
Domestic currency	89.4	89.4	89.4	74.0
Materials and equipment	6.0	6.0	6.0	-
Labor	4.4	4.4	4.4	-
Assistance and supervision	5.0	5.0	5.0	-
Agricultural development cost	74.0	74.0	74.0	74.0
Foreign currency	4.5	4.5	4.5	-
Operating costs	3076.8	3095.5	3126.7	3157.9
Domestic currency	3067.3	3086.0	3117.2	3148.4
Production costs	1669.7	1680.0	1697.1	1714.3
Labor	1366.1	1374.5	1388.6	1402.6
Maintenance and administrative costs	31.5	31.5	31.5	31.5
Foreign currency	9.5	9.5	9.5	9.5

Table B.11. Unadjusted and adjusted output and cost data, Majes project

Item	Feasibility studies base year = 1974 (million soles)
Total output	3622.9
Domestic currency	2174.0
Foreign currency	448.9
Total investment	10906.3
Domestic currency	9292.6
Materials	1419.0
Equipment	243.0
Labor	1040.6
Assistance and supervision	1580.0
Administrative costs	310.0
Farm development	4700.0
Foreign currency	1613.7
Operating costs	1746.6
Production costs	968.5
Labor	712.1
Maintenance and administrative costs	59.3
Foreign currency	6.7

[a] The output and production costs adjustments have been made according to table B.12.

[b] Rate of exchange US $1.0 = s/.70.0.

Deflator[a]	Adjusted 1976 prices (million soles)	(million dollars)
-	4874.8	69.6
-	4270.0	61.0
-	604.0	8.6
-	14757.6	210.8
-	12740.5	182.0
1.22	1730.6	24.7
1.46	354.8	5.1
1.69	1758.6	25.1
1.35	2133.0	30.5
1.35	418.5	6.0
1.35	6345.0	90.6
1.25	2017.1	28.8
-	2495.4	35.6
-	1386.3	19.8
-	1019.1	14.6
1.35	80.0	1.1
1.50	10.0	0.1

Table B.12. Unadjusted and adjsuted gross production and costs, Majes project at full output

Product	Cultivated hectares		Gross production per hectare	
	No.	%	Unadjusted[a]	Adjusted[b]
			(soles)	
Alfalfa	19630.1	26.2	25370	43998
Corn (forage)	13889.0	18.5	11485	19733
Corn (feed)	6665.0	8.9	20179	27974
Wheat	9863.6	13.2	16034	35683
Potato	2750.8	3.7	60999	84235
Beans	4008.4	5.3	17717	23032
Cotton	2850.7	3.8	19200	40344
Vegetables	5279.1	7.0	41385	49268
Barley	3155.1	4.2	11327	16792
Fruits	6094.8	8.2	73647	69326
Onion	410.7	0.5	64800	73563
Garlic	410.7	0.5	64800	74965
Total	75008.0	100.0	26888	38819
Livestock	-	-	-	-
Total project	-	-	-	-

[a]Feasibility study projection (base year = 1974).

[b]1976 prices.

Production costs per hectare		Gross production		Production costs	
Unadjusted[a]	Adjusted[b]	Unadjusted[a]	Adjusted[b]	Unadjusted[a]	Adjusted[b]
(soles)		(million soles)		(million soles)	
12258	20350	498.0	863.7	240.6	399.5
11409	21040	159.5	274.1	158.5	292.2
12207	19778	134.5	186.4	81.4	131.8
7510	17350	158.1	352.0	74.1	171.1
37840	50408	167.8	231.7	104.1	138.7
8793	11430	71.0	92.3	35.2	45.8
12996	25194	54.7	115.0	37.0	71.8
19907	26180	218.5	260.1	105.1	138.2
6613	12705	35.7	53.0	20.9	40.1
20101	21306	448.9	422.5	122.5	129.8
31616	39689	26.6	30.2	13.0	16.3
34046	67700	26.6	30.8	14.0	27.8
13417	21372	2016.7	2911.8	1006.4	1603.1
-	-	1606.2	1963.0	674.2	802.3
-	-	3622.9	4874.8	1660.6	2405.4

Table B.13. Majes project: Benefits, costs by year (at market prices)

Item		Year 1	2	3
Agricultural output	(B_t)	-	-	-
Domestic currency	(B_t^n)	-	-	-
Foreign currency	(B_t^f)	-	-	-
Total investment	(K_t)	119.4	358.2	1191.7
Domestic currency	(K_t^n)	94.2	284.5	919.6
Materials		19.1	77.3	258.6
Equipment		3.5	12.0	49.1
Labor		54.3	98.9	254.8
Assistance and supervision		13.4	79.8	298.5
Administrative costs		3.9	16.5	58.6
Farm development		-	-	-
Foreign currency	(K_t^f)	25.2	73.7	272.1
Operating costs	(C_t)	-	-	-
Domestic currency	(C_t^n)	-	-	-
Production costs		-	-	-
Labor		-	-	-
Maintenance and administrative costs		-	-	-
Foreign currency	(C_t^f)	-	-	-
Salvage value	(V_t)	-	-	-

4	5	6	7 (million soles)	8	9	10	11
-	-	-	-	158.0	298.0	417.6	742.4
-	-	-	-	138.4	262.2	365.8	650.3
-	-	-	-	19.6	35.8	51.8	92.1
1900.6	2153.7	1986.5	1400.1	634.0	634.0	698.0	825.0
1447.7	1639.1	1466.2	1242.2	634.0	634.0	698.0	825.0
393.0	451.0	377.2	154.4	-	-	-	-
85.6	97.4	79.5	27.7	-	-	-	-
377.3	420.7	391.7	160.9	-	-	-	-
495.4	561.1	517.2	167.6	-	-	-	-
96.4	108.9	100.6	33.6	-	-	-	-
-	-	-	698.0	634.0	634.0	698.0	825.0
452.9	514.6	520.3	157.9	-	-	-	-
-	-	-	-	125.3	162.4	307.2	476.1
-	-	-	-	115.3	152.4	297.2	466.1
-	-	-	-	20.2	41.7	125.1	222.4
-	-	-	-	15.1	30.7	92.1	163.7
-	-	-	-	80.0	80.0	80.0	80.0
-	-	-	-	10.0	10.0	10.0	10.0
-	-	-	-	-	-	-	-

Table B.13. (continued)

Item	12	13	14	15
Agricultural output	1206.3	1966.5	2732.2	3550.7
Domestic currency	1056.6	1722.5	2393.2	2935.0
Foreign currency	149.7	244.0	339.0	415.7
Total investment	888.0	968.0	1000.0	-
Domestic currency	888.0	968.0	1000.0	-
Materials	-	-	-	-
Equipment	-	-	-	-
Labor	-	-	-	-
Assistance and supervision	-	-	-	-
Administrative costs	-	-	-	-
Farm development	888.0	968.0	1000.0	-
Foreign currency	-	-	-	-
Operating costs	717.3	1031.0	1320.4	1561.7
Domestic currency	707.3	1021.0	1310.4	1551.7
Production costs	361.3	542.0	708.7	847.7
Labor	266.0	399.0	521.7	624.0
Maintenance and administrative costs	80.0	80.0	80.0	80.0
Foreign currency	10.0	10.0	10.0	10.0
Salvage value	-	-	-	-

16	17	18	19	20	21	22-56	57
3862.0	4143.0	4329.3	4561.3	4654.1	4874.8	4874.8	7145.8
3629.0	3629.0	3792.0	3995.4	4076.7	4270.0	4270.0	4270.0
479.1	514.0	537.1	565.9	577.4	604.8	604.8	604.8
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
1923.7	2140.7	2237.2	2357.9	2406.1	2495.4	2495.4	2495.4
1913.7	2130.7	2227.2	2347.9	2396.1	2485.4	2485.4	2485.4
1056.2	1181.2	1236.8	1306.3	1334.1	1386.3	1386.3	1386.3
777.5	869.5	910.4	961.6	982.0	1019.1	1019.1	1019.1
80.0	80.0	80.0	80.0	80.0	80.0	80.0	80.0
10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
-	-	-	-	-	-	-	2271.0

Table B.14. Unadjsuted and adjusted output and cost data, Ilo II project

Item	Feasibility studies base year = 1975 (million soles)
Total output[b]	1193.2
Total investment	5114.0
Domestic currency	2047.9
Materials	541.1
Equipment	790.2
Labor	507.6
Working capital	209.0
Foreign currency	3066.1
Materials	53.9
Equipment	2672.0
Know How	340.2
Operating costs[c]	538.4
Domestic currency	316.5
Production costs	157.5
Labor	119.0
Maintenance and administrative costs	40.0
Foreign currency	221.9

[a]Rate of exchange US $1.0 = s/.70.0.

[b]Annual gross production at full capacity.

[c]Annual operating costs at full capacity.

Deflator	Adjusted 1976 prices (million soles)	(million dollars)[a]
1.98	2362.5	33.7
-	5891.9	84.1
-	2662.3	38.0
1.31	708.8	10.1
1.25	987.7	14.1
1.41	715.8	10.2
1.20	250.0	3.6
-	3229.6	46.1
1.06	57.1	0.8
1.06	2832.3	40.4
-	340.2	4.9
-	719.9	10.3
-	404.8	5.8
1.20	189.0	2.7
1.41	167.8	2.4
1.20	48.0	0.7
1.42	315.1	4.5

Table B.15. Ilo II project: Benefits, costs by year (at market prices)

Item		Year: 1	2	3
Total output (foreign currency)	(B_t)	-	-	-
Total investment	(K_t)	1462.8	2694.0	1735.1
Domestic currency	(K_t^n)	534.6	1146.1	981.6
Materials		80.3	390.5	238.0
Equipment		226.7	507.4	253.6
Labor		227.6	248.2	240.0
Working capital		-	-	250.0
Foreign currency	(K_t^f)	928.2	1574.9	753.5
Operating costs	(C_t)	-	-	-
Domestic currency	(C_t^n)	-	-	-
Production costs		-	-	-
Labor		-	-	-
Maintenance and administrative costs		-	-	-
Foreign currency	(C_t^f)	-	-	-
Working capital and salvage value	(V_t)	-	-	-

4	5	6	7-22	23
2000.3	2157.7	2268.0	2362.5	2841.5
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
719.9	719.9	719.9	719.9	719.9
404.8	404.8	404.8	404.8	404.8
189.0	189.0	189.0	189.0	189.0
167.8	167.8	167.8	167.8	167.8
48.0	48.0	48.0	48.0	48.0
315.1	315.1	315.1	315.1	315.1
-	-	-	-	479.0

Table B.16. Unadjusted and adjusted output and cost data, Cajamarquilla project

Item	Feasibility studies, base year = 1976 (million soles)	(million dollars)[a]
Total output	3002.8	42.9
Total investment	11504.9	164.4
Domestic currency	4593.8	65.6
Materials	932.8	13.3
Equipment	2637.2	37.7
Labor	621.9	8.9
Administrative costs	58.6	0.8
Working capital	343.3	4.9
Foreign currency	6911.1	98.8
Materials	751.2	10.7
Equipment	5064.3	72.4
Assistance and supervision	1095.6	15.7
Operating costs[c]	1045.3	14.9
Domestic currency	728.4	10.4
Inputs and materials	437.3	6.3
Labor	266.8	3.8
Maintenance and administrative costs	24.3	0.3
Foreign currency	316.9	4.5

[a]Rate of exchange US $1.0 = s/.70.0.

[b]Annual gross production at full capacity.

[c]Annual operating costs at full capacity.

Table B.17. Cajamarquilla project: Benefits, costs by year (at market prices)

Item		Year 1	2	3
Total output (foreign currency)	(B_t)	-	-	-
Total investment	(K_t)	539.2	3865.3	4463.6
Domestic currency	(K_t^n)	222.3	1128.7	1783.9
Materials		102.6	727.6	46.6
Equipment		1.9	274.6	1363.9
Labor		111.9	111.9	298.5
Administrative costs		5.9	14.6	23.4
Working capital		-	-	51.5
Foreign currency	(K_t^f)	316.9	2736.6	2679.7
Operating costs	(C_t)	-	-	-
Domestic currency	(C_t^n)	-	-	-
Production costs		-	-	-
Labor		-	-	-
Maintenance and administrative costs		-	-	-
Foreign currency	(C_t^f)	-	-	-
Working capital and salvage value	(V_t)	-	-	-

4	5	6	7	8-18	19
		(million soles)			
-	2492.3	3002.8	3002.8	3002.8	4499.9
2456.5	180.3	-	-	-	-
1424.1	34.8	-	-	-	-
56.0	-	-	-	-	-
962.0	34.8	-	-	-	-
99.6	-	-	-	-	-
14.7	-	-	-	-	-
291.8	-	-	-	-	-
1032.4	145.5	-	-	-	-
-	867.7	1045.3	1045.3	1045.3	1045.3
-	604.6	728.4	728.4	728.4	728.4
-	363.0	437.3	437.3	437.3	437.3
-	221.4	266.8	266.8	266.8	266.8
-	20.2	24.3	24.3	24.3	24.3
-	263.1	316.9	316.9	316.9	316.9
-	-	-	-	-	1497.1

Table B.18. Unadjusted and adjusted output and cost data, Michiquillay project

Item	Feasibility studies base year = 1975 (million soles)
Total output[b]	5628.3
Total investment	29910.4
Domestic currency	21495.6
Materials	2583.6
Equipment	12971.8
Labor	499.8
Assistance and supervision	1454.5
Administrative costs	2170.9
Working capital	1815.0
Foreign currency	8414.8
Operating costs[c]	3971.7
Domestic currency	2732.6
Production costs	1401.4
Labor	642.6
Maintenance and administrative costs	688.6
Foreign currency	1239.1

[a]Rate of exchange US \$1.0 = s/.70.0.

[b]Annual gross production at full capacity.

[c]Annual operating costs at full capacity.

Deflator	Adjusted 1976 prices (million soles)	(million dollars)[a]
1.98	11144.0	159.2
-	35752.5	510.7
-	26832.8	383.3
1.31	3384.5	48.3
1.25	16214.8	231.6
1.41	705.0	10.1
1.20	1745.4	24.9
1.20	2605.1	37.2
1.20	2178.0	31.1
1.06	8919.7	127.4
-	4727.6	67.5
-	3414.1	48.8
1.20	1681.7	24.0
1.41	906.1	12.9
1.20	826.3	11.8
1.06	1313.5	18.7

Table B.19. Michiquillay project: Benefits, costs by year (at market prices)

Item		Year: 1	2	3
Total output (foreign currency)	(B_t)	-	-	-
Total investment	(K_t)	4824.8	5045.9	6238.1
Domestic currency	(K_t^n)	3130.1	3440.4	4543.4
Materials		637.8	517.9	562.3
Equipment		1852.2	2161.0	2932.7
Assistance and supervision		296.7	261.8	314.2
Labor		135.0	135.0	135.0
Administrative costs		208.4	364.7	599.2
Working capital		-	-	-
Foreign currency	(K_t^f)	1694.7	1605.5	1694.7
Operating costs	(C_t)	-	-	-
Domestic currency	(C_t^n)	-	-	-
Production costs		-	-	-
Labor		-	-	-
Maintenance and administrative costs		-	-	-
Foreign currency	(C_t^f)	-	-	-
Working capital and salvage value	(V_t)	-	-	-

4	5	6	7	8	9	10
			(million soles)			
-	-	-	7847.0	8890.0	9240.0	10353.0
8431.2	6767.1	3508.9	932.9	-	-	-
6022.9	5607.5	3152.0	932.9	-	-	-
752.1	1139.3	554.5	-	-	-	-
4013.2	3550.1	926.2				
471.3	314.2	87.2	-	-	-	-
135.0	135.0	30.0	-	-	-	-
651.3	468.9	312.6	-	-	-	-
-	-	1241.5	932.9	-	-	-
2408.3	1159.6	356.9	-	-	-	-
-	-	-	3660.5	4309.3	4315.1	4425.6
-	-	-	2429.6	2964.7	2998.0	3150.2
-	-	-	697.2	1232.3	1265.6	1417.8
-	-	-	906.1	906.1	906.1	906.1
-	-	-	826.3	826.3	826.3	826.3
-	-	-	1230.9	1344.6	1317.1	1275.4
-	-	-	-	-	-	-

Table B.19. (continued)

Item	11	12-21	22-25	26
Total output (foreign currency)	10950.0	11144.0	8436.0	11427.4
Total investment	-	-	-	-
Domestic currency	-	-	-	-
Materials	-	-	-	-
Equipment				-
Assistance and supervision	-	-	-	-
Labor	-	-	-	-
Administrative costs	-	-	-	-
Working capital	-	-	-	-
Foreign currency	-	-	-	-
Operating costs	4741.4	4727.6	4384.2	3876.2
Domestic currency	3414.5	3414.1	3106.0	2598.0
Production costs	1682.1	1681.7	1373.6	865.6
Labor	906.1	906.1	906.1	906.1
Maintenance and administrative costs	826.3	826.3	826.3	826.3
Foreign currency	1326.9	1313.5	1278.2	1278.2
Working capital and salvage value	-	-	-	2991.4

Table B.20. Unadjusted and adjusted output and cost data Cerro Verde II, project

Item	Feasibility studies base year = 1975 (million soles)
Total output[b]	10970.2
Total investment	77681.9
Domestic currency	35264.6
Materials	21125.6
Equipment	3672.9
Labor	3746.8
Administrative costs	3569.3
Working capital	3150.0
Foreign currency	42417.3
Materials	19290.0
Equipment	20838.3
Assistance and supervision	2289.0
Operating costs[c]	7151.8
Domestic currency	6450.2
Production costs	5540.2
Labor	490.0
Maintenance and administrative costs	420.0
Foreign currency	701.6

[a]Rate of exchange US $1.0 = s/.70.0.

[b]Annual gross production at full capacity.

[c]Annual operating costs at full capacity.

Deflator	Adjusted 1976 prices (million soles)	(million dollars)[a]
1.98	21721.0	310.3
-	90435.7	1291.9
-	45610.7	651.6
1.31	27674.5	395.4
1.25	4591.1	65.5
1.41	5281.9	75.5
1.20	4283.2	61.2
1.20	3780.0	54.0
-	44825.0	640.3
1.06	20447.4	292.1
1.06	22088.6	315.5
-	2289.0	32.7
-	8685.3	124.1
-	7843.4	112.1
1.20	6648.5	95.0
1.41	690.9	9.9
1.20	504.0	7.2
1.20	841.9	12.0

Table B.21. Cerro Verde II project: Benefits, costs by year (at market prices)

Item	Year	1	2	3
Total output	(B_t)	-	-	-
Domestic currency	(B_t^n)	-	-	-
Foreign currency	(B_t^f)	-	-	-
Total investment	(K_t)	18197.7	24263.5	26863.3
Domestic currency	(K_t^n)	8768.0	11690.6	12943.4
Materials		5811.6	7748.8	8579.2
Equipment		947.7	1263.6	1399.0
Labor		1109.2	1478.9	1637.8
Administrative costs		899.5	1199.3	1327.8
Working capital		-	-	-
Foreign currency	(K_t^f)	9429.7	12572.9	13919.9
Operating costs	(C_t)	-	-	-
Domestic currency	(C_t^n)	-	-	-
Production costs		-	-	-
Labor		-	-	-
Maintenance and administrative costs		-	-	-
Foreign currency	(C_t^f)	-	-	-
Working capital and salvage value	(V_t)	-	-	-

4	5-9 (million soles)	10-18	19
-	19594.0	21721.0	31485.7
-	879.7	1086.0	1086.0
-	18714.3	20635.0	20635.0
21111.2	-	-	-
12208.7	-	-	-
5534.9	-	-	-
980.8	-	-	-
1056.4	-	-	-
856.6	-	-	-
3780.0	-	-	-
8902.5	-	-	-
-	8061.2	8685.3	8685.3
-	7219.3	7843.4	7843.4
-	5965.2	6648.5	6648.5
-	690.9	690.9	690.9
-	563.2	504.0	504.0
-	841.9	841.9	841.9
-	-	-	9764.1

Table B.22. Unadjusted and adjusted output and cost data, La Pampilla project

Item	Feasibility studies base year = 1974 (million soles)
Total output[b]	4247.7
Total investment	4149.6
Domestic currency	1487.0
Materials	566.9
Equipment	167.8
Labor	246.1
Assistance and supervision	11.3
General expenses	178.4
Working capital	316.5
Foreign currency	2662.6
Material	3.3
Equipment	1554.0
Assistance and supervision	1105.3
Operating costs	2918.7
Domestic currency	2848.1
Production costs	2582.0
Labor	38.5
Maintenance and administrative costs	227.6
Foreign currency	70.6

[a]Rate of exchange US $1.0 = s/.70.

[b]Annual gross production at full capacity.

[c]Annual operating costs at full capacity.

Deflator	Adjusted 1976 prices (million soles)	(million dollars)[a]
4.00	16990.6	242.7
-	5633.3	80.5
-	2194.7	31.3
1.50	850.4	12.1
1.46	245.0	3.6
1.69	416.0	5.9
1.35	15.2	0.2
1.35	240.8	3.4
1.35	427.3	6.1
-	3438.6	49.1
1.20	4.0	0.1
1.25	1942.5	27.7
1.35	1492.1	21.3
-	10842.9	154.9
-	10700.3	152.9
4.00	10327.9	147.6
1.69	65.1	0.9
1.35	307.3	4.4
2.02	142.6	2.0

Table B.23. La Pampilla project: Benefits, costs by year (at market prices)

Item		Year: 1	2	3
Total output	(B_t)	-	-	-
Domestic currency	(B_t^n)	-	-	-
Foreign currency	(B_t^f)	-	-	-
Total investment	(K_t)	543.4	1280.2	2316.6
Domestic currency	(K_t^n)	209.8	543.6	776.7
Materials		39.1	345.0	342.3
Equipment		2.7	30.6	146.8
Labor		104.0	104.0	104.0
Assistance and supervision		3.8	3.8	3.8
General expenses		60.2	60.2	60.2
Working capital		-	-	119.6
Foreign currency	(K_t^f)	333.6	736.6	1539.9
Operating costs	(C_t)	-	-	-
Domestic currency	(C_t^n)	-	-	-
Production costs		-	-	-
Labor		-	-	-
Maintenance and administrative costs		-	-	-
Foreign currency	(C_t^f)	-	-	-
Working capital and salvage value	(V_t)	-	-	-

4	5	6	7	8	9	10-22	23
			(million soles)				
5097.0	7645.9	12743.1	16990.8	16990.8	16990.8	12049.3	12606.4
3134.7	4702.2	7837.0	10449.3	10449.3	10449.3	12049.3	12049.3
1962.3	2943.7	4906.7	6541.5	6541.5	6541.5	-	-
1493.1	-	-	-	-	-	-	-
664.6	-	-	-	-	-	-	-
124.0	-	-	-	-	-	-	-
64.9	-	-	-	-	-	-	-
104.0	-	-	-	-	-	-	-
3.8	-	-	-	-	-	-	-
60.2	-	-	-	-	-	-	-
307.7	-	-	-	-	-	-	-
828.5	-	-	-	-	-	-	-
3252.9	4879.2	8132.0	10842.9	10842.9	10842.9	10842.9	10842.9
3210.1	4815.0	8025.0	10700.3	10700.3	10700.3	10700.3	10700.3
3098.4	4647.4	7745.8	10327.9	10327.9	10327.9	10327.9	10327.9
19.5	29.3	48.8	65.1	65.1	65.1	65.1	65.1
92.2	138.3	230.4	307.3	307.3	307.3	307.3	307.3
42.8	64.2	107.0	142.6	142.6	142.6	142.6	142.6
-	-	-	-	-	-	-	557.1

Table B.24. Unadjusted and adjusted output and cost data, Steel Plant, project

Item	Feasibility studies base year = 1974 (million soles)
Total output[b]	22189.1
Total investment	47801.2
Domestic currency	28997.5
Materials	7736.9
Equipment	3292.5
Labor	5036.1
Assistance and supervision	5232.0
Working capital	7700.0
Foreign currency	18803.7
Operating costs[c]	11430.2
Domestic currency	11198.1
Production costs	9332.5
Labor	1144.6
Maintenance and administration costs	721.0
Foreign currency	232.1

[a]Rate of exchange US $1.0 = s/.70.0.

[b]Annual gross production at full capacity.

[c]Annual operating costs at full capacity.

Deflator	Adjusted 1976 prices (million soles)	(million dollars)[a]
1.61	35791.1	511.3
-	65907.2	941.5
-	42402.6	605.7
1.50	11606.3	165.8
1.46	4807.1	68.7
1.69	8511.0	121.6
1.35	7083.2	101.2
1.35	10395.0	148.5
1.25	23504.6	335.8
-	18969.8	270.9
-	18679.7	266.8
1.69	15772.0	225.3
1.69	1934.4	27.6
1.35	973.3	13.9
1.25	290.1	4.1

Table B.25. Steel Plant project: Benefits, costs by year (at market prices)

Item		Year: 1	2	3
Total output	(B_t)	-	-	-
Domestic currency	(B_t^n)	-	-	-
Foreign currency	(B_t^f)	-	-	-
Total investment	(K_t)	75.1	4565.8	16524.0
Domestic currency	(K_t^n)	45.2	2682.1	9253.6
Materials		16.7	1050.3	4451.1
Equipment		6.4	398.9	1585.3
Labor		12.3	620.0	620.0
Assistance and supervision		9.8	612.9	2597.2
Working capital		-	-	-
Foreign currency	(K_t^f)	29.9	1883.7	7270.4
Operating costs	(C_t)	-	-	-
Domestic currency	(C_t^n)	-	-	-
Production costs		-	-	-
Labor		-	-	-
Maintenance and administrative costs		-	-	-
Foreign currency	(C_t^f)	-	-	-
Working capital and salvage value	(V_t)	-	-	-

4	5	6	7	8
		(million soles)		
-	5368.7	13242.7	16106.0	17537.6
-	5088.7	11142.7	13026.0	13407.6
-	280.0	2100.0	3080.0	4130.0
11509.7	6040.7	3407.0	4382.2	3754.3
6456.6	3281.8	1876.9	3080.0	2063.5
2825.5	568.1	368.2	484.4	703.3
1070.9	472.2	267.9	247.9	330.4
620.0	620.0	620.0	620.0	620.0
1940.2	331.5	214.8	282.7	409.8
-	1290.0	406.0	1445.0	-
5053.1	2758.9	1530.1	1302.2	1690.8
-	3546.3	7439.3	8854.9	9562.8
-	3502.8	7331.9	8724.4	9420.6
-	2555.1	5949.2	7183.4	7800.5
-	290.2	715.7	870.5	947.9
-	657.5	667.0	670.5	672.2
-	43.5	107.4	130.5	142.2
-	-	-	-	-

Table B.25. (continued)

Item	9	10	11
Total output	19327.2	21116.7	24337.9
Domestic currency	13797.2	13696.7	15937.9
Foreign currency	5530.0	7420.0	8400.0
Total investment	2228.9	1517.7	1509.7
Domestic currency	1760.1	3181.4	1235.1
Materials	262.2	116.0	116.0
Equipment	99.4	33.5	53.9
Labor	620.0	620.0	620.0
Assistance and supervision	153.0	67.7	67.7
Working capital	625.5	544.2	377.5
Foreign currency	468.8	136.3	274.6
Operating costs	10829.8	11714.5	13307.2
Domestic currency	10673.2	11543.4	13110.0
Production costs	8675.2	9446.5	10835.1
Labor	1044.6	1141.3	1315.4
Maintenance and administrative costs	953.4	955.3	959.5
Foreign currency	156.6	171.1	197.1
Working capital and salvage value	-	-	-

12	13	14	15	16-24	25
		(million soles)			
25411.7	27917.1	30422.4	32927.8	35791.1	45568.6
14981.7	15667.1	16632.4	16127.8	18991.1	18991.1
10430.0	12250.0	13790.0	16900.0	16800.0	16800.0
2478.2	2978.8	3732.4	1202.7	-	-
2199.7	2410.1	3540.8	1135.7	-	-
346.6	150.9	90.0	57.0	-	-
81.0	101.2	45.2	13.0	-	-
620.0	620.0	620.0	458.7	-	-
202.3	88.0	85.6	-	-	-
949.8	1450.0	2700.0	607.0	-	-
278.5	568.7	191.6	67.0	-	-
13838.0	15076.6	16315.4	17553.2	18969.8	18969.8
13632.1	14850.4	16068.8	17286.4	18979.7	18679.7
11297.9	11277.8	13457.8	14536.9	15772.0	15772.0
1373.4	1508.8	1644.2	1779.6	1934.4	1934.4
960.8	963.8	966.8	969.9	973.3	973.3
205.9	226.2	246.6	266.8	290.1	290.1
-	-	-	-	-	9777.5

Table B.26. Unadjusted and adjusted output and cost data, Fertilizer, project

Item	Feasibility studies base year = 1971 (million soles)
Total output[b]	588.0
Total investment	1870.2
Domestic currency	780.6
Materials	50.1
Equipment	365.9
Labor	109.6
General expenses	44.6
Working capital	210.4
Foreign currency	1089.6
Materials	31.2
Equipment	1058.4
Operating costs[c]	353.5
Inputs and materials	275.1
Labor	13.8
Spare parts	22.4
Maintenance and administration costs	42.2
(Foreign currency)	-

[a]Rate of exchange US $1.0 = s/.70.0.

[b]Annual gross production at 71 percent of full capacity.

[c]Annual operating costs at full capacity.

Deflator	Adjusted 1976 prices (million soles)	(million dollars)[a]
2.42	1423.0	20.3
-	3634.8	52.0
	1661.1	23.8
1.78	89.2	1.3
2.02	739.1	10.6
2.41	264.1	3.8
2.23	99.5	1.4
2.23	469.2	6.7
	1973.7	28.2
1.86	58.0	0.8
1.81	1915.7	27.4
-	709.0	10.1
1.95	536.4	7.7
2.41	33.2	0.5
2.02	45.3	0.6
2.23	94.1	1.3
-	(3.0)	-

Table B.27. Fertilizer project: Benefits, costs by year (at market prices)

Item		Year: 1	2	3
Total output (foreign currency)	(B_t)	-	-	925.0
Total investment	(K_t)	930.8	2704.0	-
Domestic currency	(K_t^n)	358.5	1202.6	-
Materials		26.0	63.2	-
Equipment		227.0	412.1	-
Labor		76.6	187.5	-
General expenses		28.9	70.6	-
Working capital		-	469.2	-
Foreign currency	(K_t^f)	572.3	1501.4	-
Operating costs	(C_t)	-	-	521.3
Domestic currency	(C_t^n)	-	-	518.3
Production costs		-	-	348.7
Labor		-	-	33.2
Maintenance and administrative costs		-	-	136.4
Foreign currency	(C_t^f)	-	-	3.0
Working capital and salvage value	(V_t)	-	-	-

4	5	6	7	8	9	10
			(million soles)			
996.1	1067.2	1138.4	1209.5	1280.7	1351.8	1366.1
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
568.3	600.6	629.1	651.6	670.9	680.0	686.5
565.3	597.6	626.1	648.6	667.9	677.0	683.5
395.9	428.0	456.5	479.0	498.3	507.4	513.9
33.2	33.2	33.2	33.2	33.2	33.2	33.2
136.4	136.4	136.4	136.4	136.4	136.4	136.4
3.0	3.0	3.0	3.0	3.0	3.0	3.0
-	-	-	-	-	-	-

Table B.27. (continued)

Item	11	12	13-16	17
Total output (foreign currency)	1380.3	1394.5	1423.0	2176.2
Total investment	-	-	-	-
Domestic currency	-	-	-	-
Materials	-	-	-	-
Equipment	-	-	-	-
Labor	-	-	-	-
General expenses	-	-	-	-
Working capital	-	-	-	-
Foreign currency	-	-	-	-
Operating costs	692.9	699.3	709.0	709.0
Domestic currency	689.9	696.3	706.0	706.0
Production costs	520.3	526.7	536.4	536.4
Labor	33.2	33.2	33.2	33.2
Maintenance and administrative costs	136.4	136.4	136.4	136.4
Foreign currency	3.0	3.0	3.0	3.0
Working capital and salvage value	-	-	-	753.2

Table B.28. Unadjusted and adjusted output and cost data, Yura project

Item	Feasibility studies base year = 1974 (million soles)
Total output[b]	259.4
Total investment	1075.1
Domestic currency	557.3
Materials	136.9
Equipment	198.0
Labor	75.7
Assistance and supervision	41.3
General expenses	105.4
Foreign currency	517.8
Operating costs[c]	154.4
Production costs	108.9
Labor	16.3
Maintenance and administration costs	29.2
(Foreign currency)	

[a]Rate of exchange US $1.0 = s/.70.0.

[b]Annual gross production at full capacity.

[c]Annual operating costs at full capacity.

Deflator	Adjusted (million soles)	(million dollars)[a]
1.91	495.4	7.1
	1467.7	21.0
	820.4	11.6
1.50	205.4	2.9
1.46	289.0	4.1
1.69	127.9	1.8
1.35	55.8	0.8
1.35	142.3	2.0
1.25	647.3	9.4
	252.4	3.6
1.69	184.0	2.6
1.69	27.5	0.4
1.35	39.4	0.6
	(1.5)	-

Table B.29. Yura project: Benefits, costs by year (at market prices)

Item		Year: 1
Total output	(B_t)	-
Domestic currency	(B_t^n)	-
Foreign currency	(B_t^f)	-
Total investment	(K_t)	312.8
Domestic currency	(K_t^n)	135.4
Materials		-
Equipment		45.4
Labor		25.9
Assistance and supervision		16.7
General expenses		47.4
Foreign currency	(K_t^f)	177.4
Operating costs	(C_t)	-
Domestic currency	(C_t^n)	-
Production costs		-
Labor		-
Maintenance and administrative costs		-
Foreign currency	(C_t^f)	-
Salvage value	(V_t)	-

2	3	4	5-17	18
-	-	495.4	495.4	576.4
-	-	446.0	446.0	446.0
-	-	49.4	49.4	49.4
731.1	423.8	-	-	-
341.6	343.4	-	-	-
92.4	113.0	-	-	-
134.1	109.5	-	-	-
51.0	51.0	-	-	-
16.7	22.4	-	-	-
47.4	47.5	-	-	-
389.5	80.4	-	-	-
-	-	252.4	252.4	252.4
-	-	250.9	250.9	250.9
-	-	184.0	184.0	184.0
-	-	27.5	27.5	27.5
-	-	39.4	39.4	39.4
-	-	1.5	1.5	1.5
-	-	-	-	81.0